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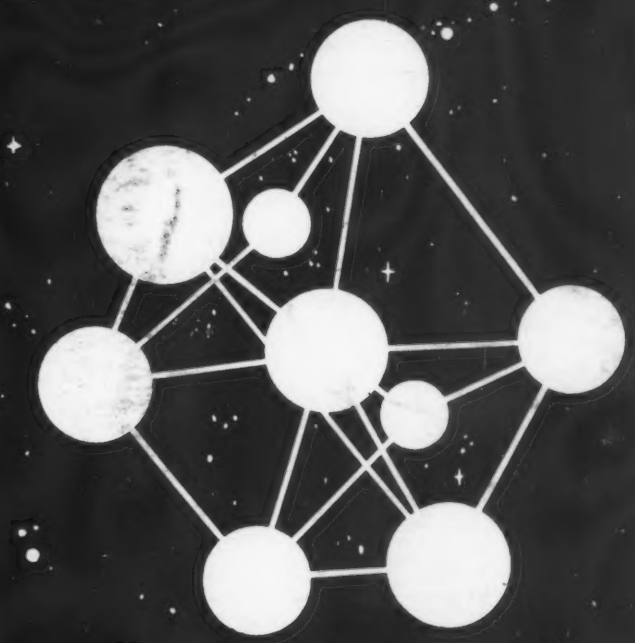

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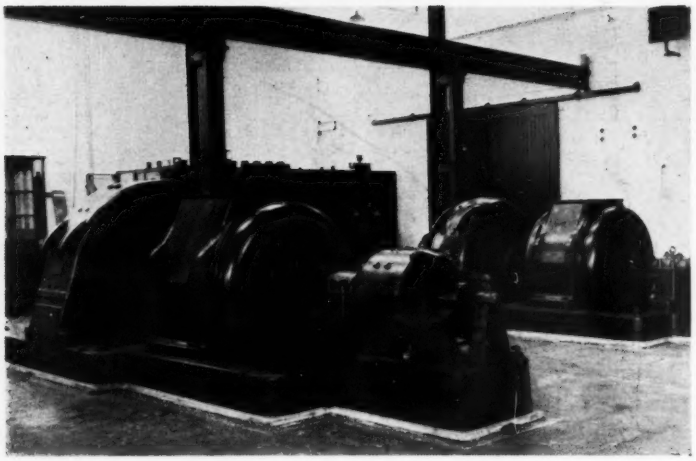

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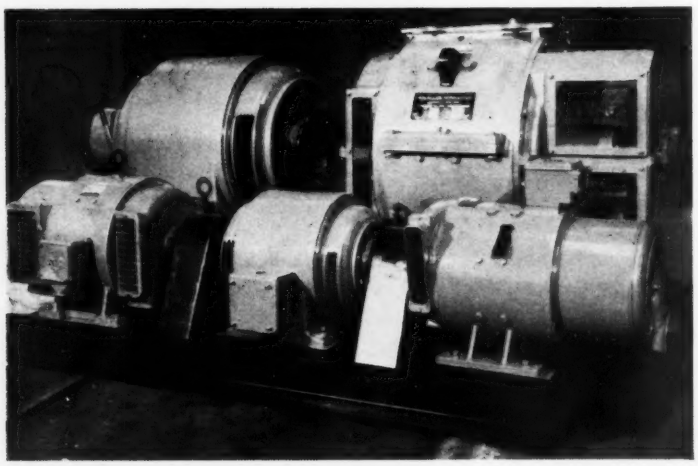

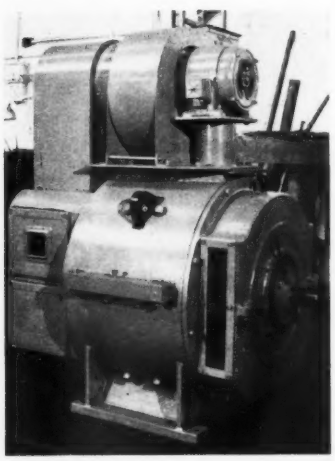

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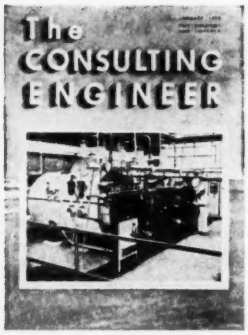

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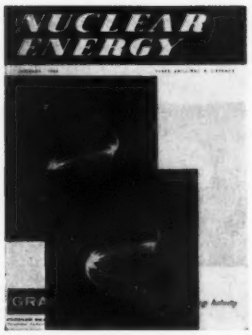

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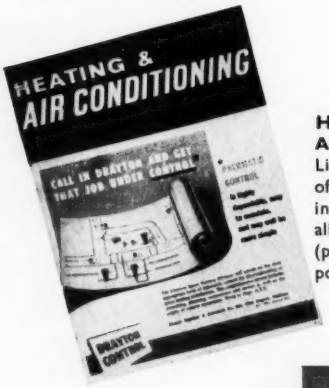

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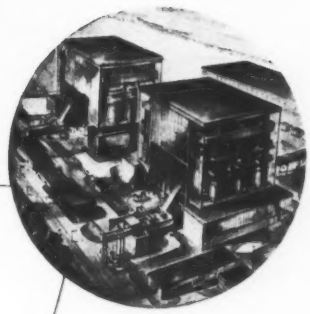

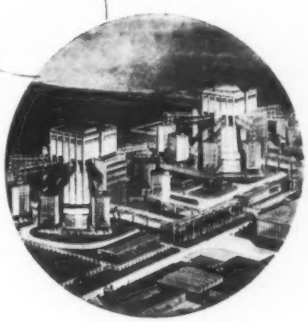

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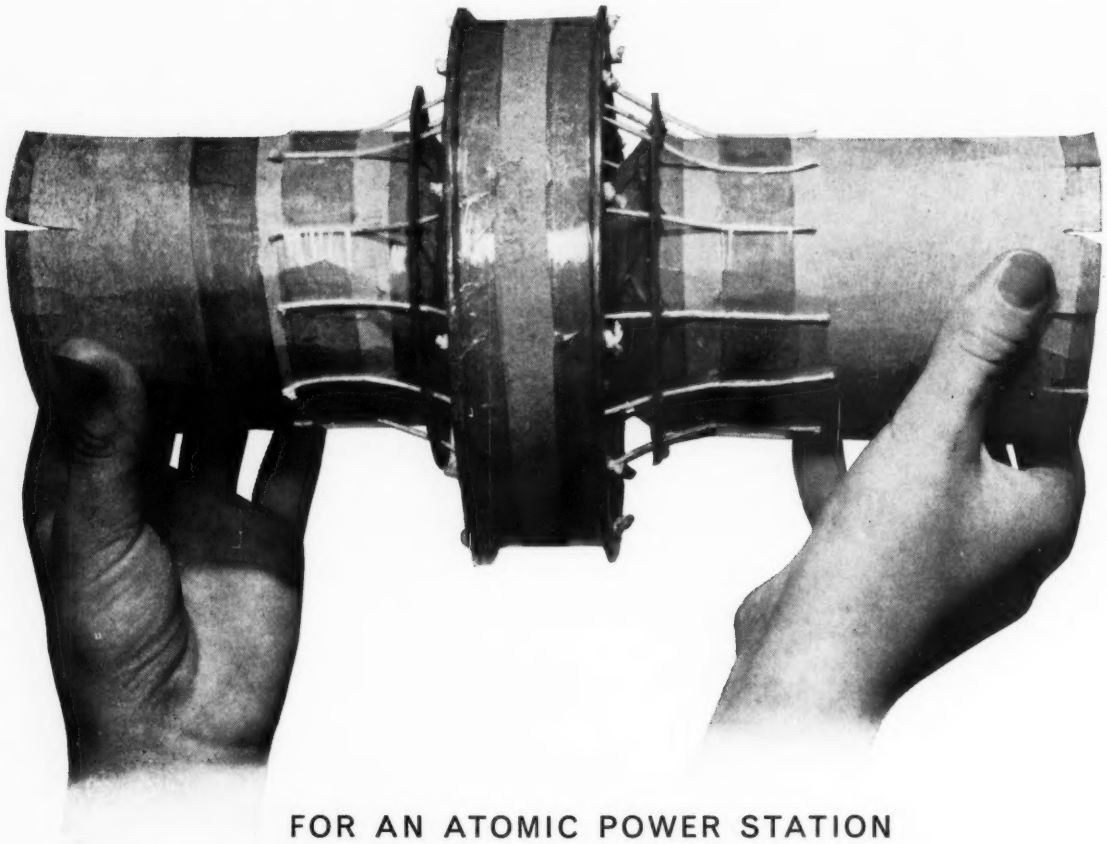

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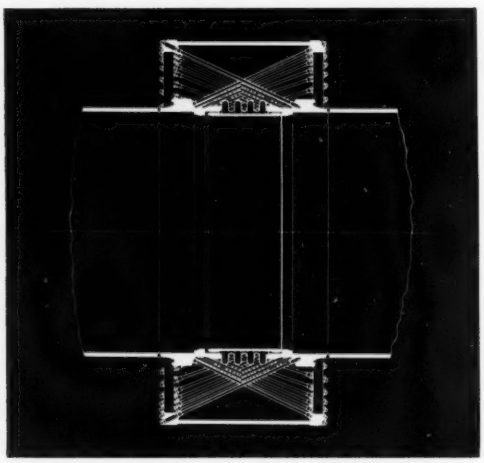

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Design and operation of the radiochemistry laboratory

Part I

by G. R. Hall, Imperial College, London

HEALTH physics and various aspects of radiological protection have been discussed in some detail in a series of papers by Gould[1], but it is necessary to refer here to those features of protection which are important in considering the design of laboratories for the safe handling of radioactive materials. Thus, if a laboratory is required only for the handling of low-level activities of, say, phosphorus-32, the standard of the laboratory can be much inferior to that required for the handling of plutonium. This is because the phosphorus is a pure beta-emitter and an isotope which represents a relatively low biological hazard, whereas plutonium is a long-lived alpha emitter which selectively deposits in particular parts of the body tissue. As a result, plutonium, which presents virtually no external radiation hazard, is an extremely dangerous material if it is ingested into the body, the body burden is less than 1 microgram (μg). Plutonium must therefore be handled with extreme care and in a laboratory designed for the purpose, *e.g.*, it is essential to carry out all experiments with solutions containing up to a few millicuries of plutonium in well-ventilated fume hoods and all experiments with larger quantities of plutonium in solution, all sizeable quantities of plutonium-containing solids must be in enclosed glove boxes (Figs. 1 and 2).

On the other hand, in handling millicurie amounts of phosphorus-32, the main precaution arises in providing local shielding from the beta radiation, *e.g.*, glass vessels and Perspex shields sited in a fume hood. Materials which emit gamma radiation, however, may present an appreciable ingestion hazard (internal radiation hazard) and always lead to a shielding problem and hence an external radiation hazard. Caesium-137, a long-lived beta-gamma emitter, is an example. In handling this isotope it is essential to ensure that remote handling techniques and lead shielding are available to protect the operator from the penetrating gamma radiation. The thickness of shielding required, of course, depends on the quantity of caesium being handled. Thus, 3 in. of lead will reduce the radiation dose-rate from a source emitting 1 MeV gammas by a factor of 100, whereas 1 in. of lead will provide the same degree of protection for gammas of energy 0.35 MeV. The problems of shielding are complex but it is often possible to make sufficiently good approximations of shielding thickness from graphs of gamma absorption. Such graphs for absorption in lead, water, aluminium, etc., are available[2].

The more important facts which must be considered in designing a radiochemistry laboratory are as follows.

Design Considerations

The laboratory must be operated in such a manner that radioactive materials can be handled with complete safety to the operator, to other persons in the laboratory and without danger to persons outside the laboratory. It may be assumed that, with few exceptions, all work with active materials will be carried out in fumehoods, glove boxes, or other protected areas and that unprotected bench space in the laboratory will be used only for inactive work. With extensive use of fumehoods an adequate and often elaborate air extraction system is necessary. The extracted air may require filtration, especially if high levels of activity are to be handled in the fumehoods; the efficiency required for the filters will be decided by the external surroundings of the laboratory.

If extensive lead shielding is likely to be used it will be necessary to ensure that the fumehoods are able to support a considerable mass of lead, similar considerations may apply to the floor loadings.

Attention has already been drawn to the need for protecting persons

(*Continued on p.* 61)

THE AUTHOR

Mr. Hall, after graduating at Manchester University, joined the staff of the Chemistry Division at the Atomic Energy Research Establishment at Harwell where he worked in the field of radiochemistry and heavy element chemistry. He was seconded, as a Colombo Plan Expert, to the Indian Atomic Energy Establishment in Bombay in 1956 where he was responsible for the design, construction and stcffing of the first Indian high-level radiochemical laboratory. He retuned to London in 1958, on appointment to the new readership in Nuclear Technology at the Imperial College of Science and Technology.

Mr. Hall talking to the Indian Prime Minister, Mr. Nehru, at the Radiochemistry Laboratory at the Indian Atomic Energy Establishment at Trombay, Bombay, India

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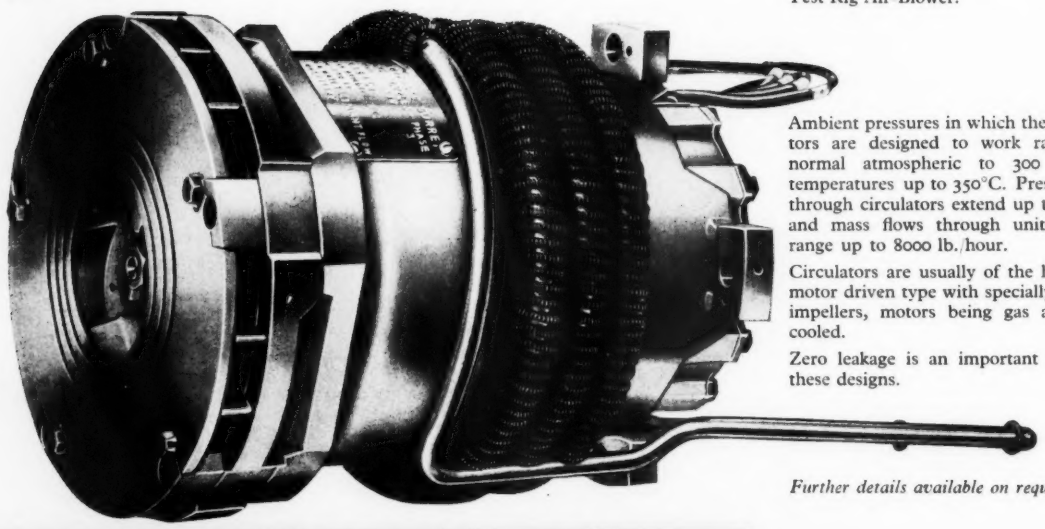

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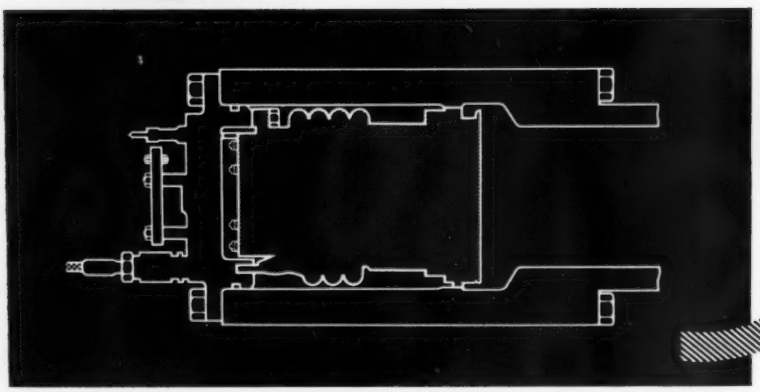

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(*Continued from page* 59)

outside the laboratory. Care must therefore be taken in siting the laboratory and in ensuring that radiation or radioactive materials cannot lead to any hazard in surrounding areas. Apart from filtration of extracted air, it may also be advisable to guard against inadvertent loss of radioactive substances through the drainage system, *e.g.*, from sinks. In laboratories intended for high level work, particularly with materials such as polonium, plutonium, caesium-137, etc., it is essential to provide delay tanks in the drainage system. These can act as holding tanks if there should be an accidental release of dangerous amounts of radioactive effluent. On the other hand, small amounts of radioactive substances can be permitted in normal drainage systems and so the necessity for providing special drainage facilities depends on the type of work for which the laboratory is being designed.

Contamination Control

Mention has been made of external and internal radiation hazards. The latter may arise in careless work if radioactive materials become accidentally spread about the laboratory—thus leading to radioactive contamination. As will be shown, many features of the laboratory are designed to minimize spread of contamination, *e.g.*, active work is confined to certain areas of the laboratory, such as fumehoods, care is taken to achieve a good finish to the walls, ceiling and floor to reduce collection of dust on cracks and ledges (small quantities of radioactive substances may be spread on dust particles), and to provide working surfaces which may readily be cleaned or decontaminated after accidental contamination. In fact, it is often claimed that the model radiochemistry laboratory should have hospital standards of construction and finish.

Contamination is a problem not only because of possible danger to people in the affected area, its contribution to external radiation and the danger of producing an ingestion hazard, but also because unexpected radioactive material may be sufficient to affect experimental results. This is particularly so when one operator may be engaged on low-level radiochemical analysis requiring sensitive counting techniques in a laboratory in which larger quantities of radioactivity are also being handled. In such circumstances, it is advisable to isolate low-level active work and this is best done by allocating separate laboratories for different levels of activity. Thus it is usual to keep all nuclear counting equipment in one room, the counting room, and to arrange laboratories in order of increasing levels of activity. This is illustrated in the layout of the radiochemical laboratories at the Atomic Energy Research Establishment at Harwell[3] and at Oak Ridge.

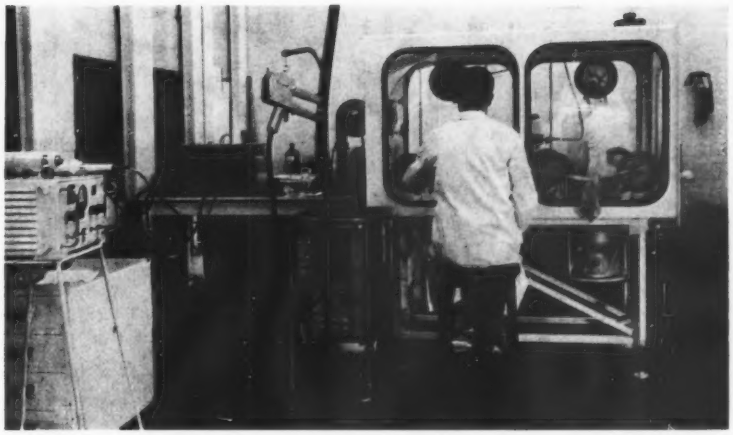


Fig. 1.—A glove box in one of the Nuclear Technology Laboratories, Imperial College

Laboratory Classification

It can be seen that there are many unusual features to the radiochemistry laboratory and it is a very difficult matter to lay down adequate specifications except perhaps in the case of a laboratory intended for a limited range of work. Binks has classified a wide range of radioactive isotopes in groups according to their toxicity (Table 1) and an attempt has been made to relate the quantities of these isotopes which may be handled in various classes of laboratory, depending on the quality of finish and the facilities available. Table 2 shows the suggested ranges of activities of different classes of isotopes for laboratories designated types *A*, *B* and *C*. It will be noted that certain modifying factors are introduced to take account of chemical operations which can lead to varying degrees of hazard, *e.g.*, work with a dry powder is considered to be 100 times more hazardous than simple wet operations.

Type *A* laboratories are those specially designed and constructed to handle large amounts of radioactive materials (Fig. 3). They are provided with an efficient air conditioning plant which includes rigorous filtration of the extracted air and separate drainage leading through delay tanks. It is usually difficult or impossible to modify adequately an existing laboratory to this standard.

The type *B* laboratory is often similar to type *A* but standards are not quite so stringent. Thus a high quality chemical laboratory provided with additional fumehoods, improved ventilation and good work surfaces may come into this classification. It is unfortunate, however, that many university and industrial laboratories are of such poor quality that they rarely achieve type *B*

Table 1.—Classification of Radioisotopes according to Relative Radiotoxicity per Unit Amount

(The isotopes in each class are listed in order of increasing atomic number)

Class I (very high toxicity): $Sr^{90} + Y^{90}$, $Pb^{210} + Bi^{210}$ (RaD + RaE), Po^{210}, At^{211}, $Ra^{226} + 55$ per cent. daughter products, Ac^{227}, U^{233}, Pu^{239}, Am^{241}, Cm^{242}.

Class II (high toxicity): Ca^{45}, Fe^{59}, Sr^{89}, Y^{91}, $Ru^{106} + Rh^{106}$, I^{131}, $Ba^{140} + La^{140}$, $Ce^{144} + Pr^{144}$, Sm^{151}, Eu^{154}, Tm^{170}, $Th^{234} + Pa^{234}$, natural thorium, natural uranium.

Class III (moderate toxicity): Na^{22}, Na^{24}, P^{32}, S^{35}, Cl^{36}, K^{42}, Sc^{46}, Sc^{47}, Sc^{48}, V^{48}, Mc^{52}, Mn^{54}, Mn^{56}, Fe^{55}, Co^{58}, Co^{60}, Ni^{59}, Cu^{64}, Zn^{65}, Ga^{72}, As^{74}, As^{76}, Br^{82}, Rb^{86}, $Zr^{95} + Nb^{95}$, Nb^{95}, Mo^{99}, Tc^{96}, Rh^{105}, $Pd^{103} + Rh^{103}$, Ag^{105}, Ag^{111}, $Cd^{109} + Ag^{109}$, Sn^{113}, Te^{127}, Te^{129}, I^{132}, $Cs^{137} + Ba^{137}$, La^{140}, Pr^{143}, Pm^{147}, Ho^{166}, Lu^{177}, Ta^{182}, W^{181}, Re^{183}, Ir^{190}, Ir^{192}, Pt^{191}, Pt^{193}, Au^{196}, Au^{198}, Tl^{200}, Tl^{202}, Tl^{204}, Pb^{203}.

Class IV (slight toxicity): H^3, Be^7, C^{14}, F^{18}, Cr^{51}, Ge^{71}, Tl^{201}.

Fig. 2.—Operations inside the glove box require the operator to wear shoulder-length rubber gloves. This chemist is handling plutonium solutions

standards without extensive modifications.

The type *C* laboratory is usually one designed for normal chemical work but which may have been improved by the addition of more adequate fumehoods, better working surfaces and a suitable floor covering. Active drainage facilities are not necessary and it is not usual to filter the air extracted from the fumehoods unless, perhaps, the extraction is into a main ducting which could lead to active air reaching other laboratories.

More detailed specifications for the laboratory designer will now be discussed, with particular reference to type *A* laboratories. It should be re-emphasized, however, that nearly every laboratory has its own peculiar features and it is never possible to be dogmatic in recommending design specifications.

Laboratory Layout

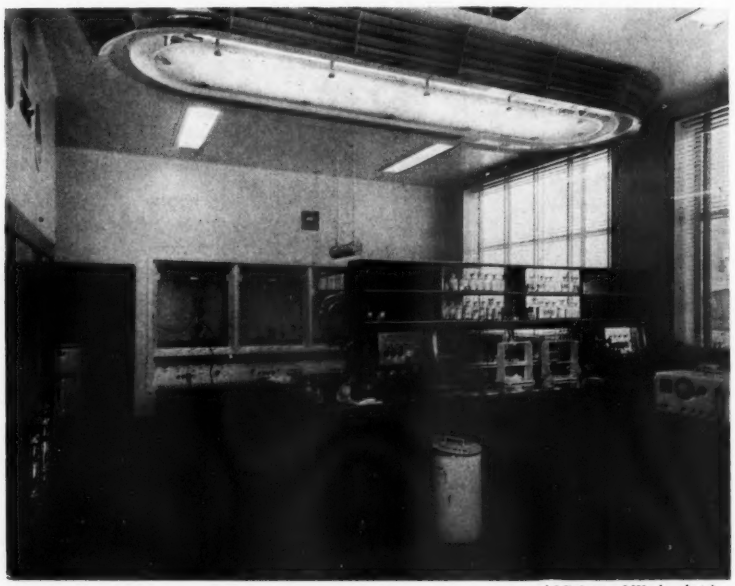
In designing a major building the architect will be faced with providing not only the radiochemistry laboratories but also areas for the ancillary groups such as health physics, electronics maintenance, workshop and engineering maintenance staff, etc. The supporting groups may well require more space than the scientific staff. The design of such buildings is, however, outside the scope of this paper but the criteria of layout remains basically similar. Firstly all rooms and facilities which do not need to be within the active area are confined to a zone of free access, inactive area. It may well be considered that staff offices fall into this category. On grounds of convenience, however, it now seems to be well accepted that in larger installations it is more profitable to site them close to the appropriate laboratories. In considering the layout of a single laboratory or a group of several small laboratories, it is more convenient to keep the offices in the inactive area. Similar arguments may apply to the siting of counting rooms. It is usual to site them in the active area for convenience, although the levels of activity taken into them do not usually justify such a precaution. It is especially important to ensure that they are well separated from laboratories used for handling high levels of activity and especially from sources of penetrating radiation. For example, a multi-kilocurie cobalt source which is adequately shielded according to ICRP* recommendations may still provide sufficient numbers of gamma photons to affect the gamma background of a sensitive scintillation counter. This difficulty has arisen in the Nuclear Technology Laboratory at Imperial College; the counting room being only 30 ft from a kilocurie cobalt source, although the source itself is adequately shielded.

When the designer, with the advice of the scientist who is to use the laboratory, has decided on the number of rooms and the extent of special facilities required within the active area, he can then plan a detailed layout.

It is usual to provide a buffer zone between the active and inactive areas. In the larger buildings this zone

*International Commission on Radiological Protection.

Fig. 3.—Example of a type A laboratory in the Radiochemistry Building Harwell



(Ministry of Works photo)

Table 2.—Grading of Laboratories for Work involving Normal Chemical Operations with Unsealed Isotopes

(Gradings indicate approximate levels)

Class of Isotope	Grade of Laboratory		
	C	*B*	*A*
	max.	max.	
I ..	10 μc	1 mc	>1 mc
II ..	100 μc	10 mc	>10 mc
III ..	1 mc	100 mc	>100 mc
IV ..	10 mc	1 c	>1 c

The above quantities should be modified, according to the type of work, where it differs from normal chemical operations. Storage presents less hazard, so quantities can be increased, while dusty operations increase the probability of inhalation.

A table of modifying factors is given below:

Procedure	*Factor*
Storage (stock solutions) ..	x100
Very simple wet operations ..	x 10
Normal chemical operations ..	x 1
Complex wet operations with risk of spills	x 0.1
Simple dry operations	x 0.1
Dry and dusty operations ..	x 0.01

Example of application of modifying factor

In a Grade *B* laboratory normal chemical operations may be carried out with quantities up to 10 mc of Fe^{59} (Class II isotope). If, however, the work is concerned with dry grinding of metallic samples containing Fe^{59}, then the maximum permissible quantity of 100 μc (modifying factor x 0.01).

Fig. 4.—Health physicist monitors the floor with a large area alpha scintillation floor probe. The barrier at the entrance to the active area can just be seen in the foreground. The rack at the left contains shoe bags

may well play an essential part in the arrangements for balancing ventilation air flows between the two parts of the building. In any laboratory it will represent the point where radiological precautions commence, *e.g.*, wearing of laboratory coats and " active " shoes or a complete change of clothing may become essential. Many workers favour an actual barrier over which a person must step to emphasize the different zones. In the Nuclear Technology Laboratory (Fig. 4) there is a removable barrier and on stepping over this overshoes are donned. In the area immediately outside the laboratory there is also a hand and clothing monitor and it is advisable to provide hand wash basins. The layout of a typical laboratory suite, containing entrance lobby, office and laboratory, is illustrated by Spence[3].

Subsequent arrangements of laboratories in the active area should as far as possible follow the principle of progression from lower to higher levels of activity. It is often, however, impossible to be rigid over layout as laboratory programmes vary and it may not become feasible to use individual laboratories for their designed purpose. It is better to over-design a laboratory from the start, as it is so difficult to modify a laboratory especially after it has once been used under active conditions.

(To be continued)

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WE ACKNOWLEDGE WITH THANKS

Calendars from: Danfoss of Denmark; Caterpillar Tractor Co., Ltd.; Matthews & Yates, Ltd.; Cable Supports, Ltd.; International Harvester Co. of Great Britain, Ltd.; The Rheostatic Co., Ltd.; Hall Harding, Ltd.; Rymans, Ltd.; Sir W. H. Bailey & Co., Ltd.; Higgs (Air Agency), Ltd.; Robert Watson & Co.; Shaw, Son & Greenralph, Ltd.; Shell Mex and B.P., Ltd.; The National Trust; Heating & General Engineering Co.; Catford, Ltd.; Crofts (Engineers), Ltd.; Stewarts & Lloyds, Ltd.; Light & Son, Ltd.; Le Bas Tube Co., Ltd.; Wimpey, Ltd.; Mavor & Coulson, Ltd.; Burdette & Co., Ltd.; Midland Electric Manufacturing Co., Ltd.; Watford Electric & Manufacturing Co., Ltd.; Anson, Ltd.; British Insulated Callenders Cables, Ltd.; Lang Pneumatic, Ltd.; A. C. Smith, Ltd.; Grosvenor Engineering Co., Ltd.; Aveling Barford, Ltd.; Holman Bros., Ltd.; Edward Deane & Beale, Ltd.; Hugh Wood & Co., Ltd.; Cape Asbestos Co., Ltd.; Harland & Wolff, Ltd.; John Laing & Son, Ltd.; Woodfield Rochester, Ltd.; Kodak, Ltd.; G.E.C., Ltd.; Hawker Siddeley Industries, Ltd.; Lang Pneumatic, Ltd.

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Christmas Cards: We would like to thank also the 836 readers and advertisers who sent us Christmas Cards.

NEW NUCLEAR AIDS TO PROCESS CONTROL

by F. R. Paulsen, BSc, PhD, FRIC, FCS, MINucE.
(Member of Council)

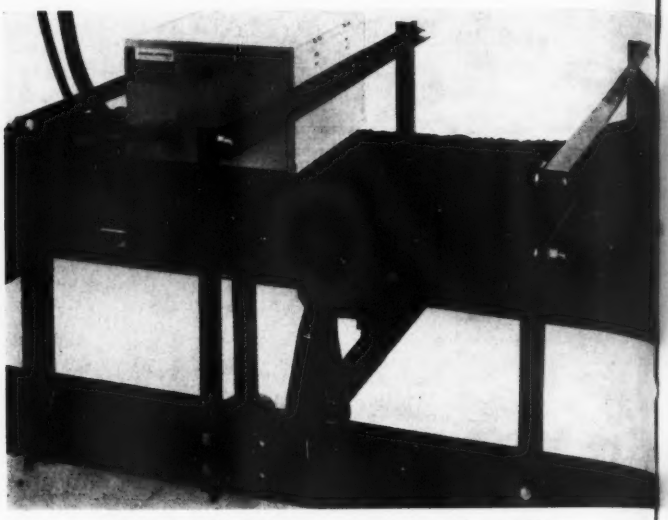


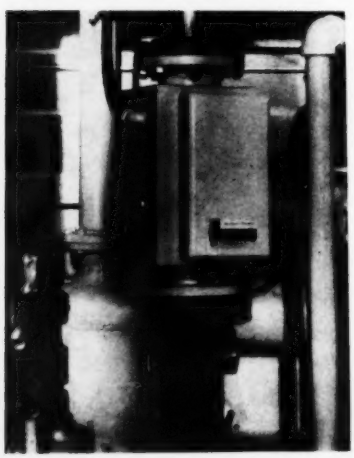
Fig. 1.—Model 502 bulk density gauge, measuring and controlling the bulk density of solid materials. The measuring head is directly above the material, and may also be a long probe which can be inserted into the contents of the bin or hopper

APPLICATIONS of isotopes and radiations in industry were first made to various types of process control, and adaptations to this sort of work have progressed in step with the many other industrial uses of radiations which have been the product of the combined skill and ingenuity of scientists, engineers and technologists.

The U.S.A., as might be expected from its position among the atomic pioneering countries exploited industrial isotopes at a very early stage, and the pace of progress has never been reduced. Among the firms which have forged ahead in process control by means of nuclear devices is the well-known Nuclear Chicago Corporation, of Des Plaines, Illinois.

In the autumn of 1960, it was announced by James M. Phelan, chairman of the board and president of NCC, that the company's year-old Industrial Division had developed four new instrumentation systems for industrial processes. Marketed under the name " Qualicon Systems," these instruments are designed for continuous measurement and control of moisture and density of materials on conveyor belts, in pipes, in bins and hoppers, and in tanks, mixers and blenders.

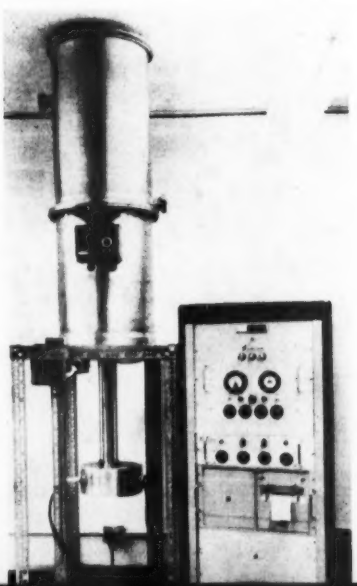
Fig. 2.—Model 504 liquid density gauge, controlling the density of solutions or slurries. The measuring head fits into systems with three to eight inch pipes



These devices were shown for the first time in September, 1960 at the Instruments Society of America meeting in New York, where they attracted a great deal of attention and interest. Since the control of moisture and density is vitally important in many industrial processes, the potential markets for such instrumental aids are very great. Formerly determinations of density and moisture content required laborious and time-consuming analyses, but these will become a thing of the past if methods employing Qualicon systems are used. The Qualicon gauges make possible routine, automatic measurement and control right on the process line.

The model 502 series of bulk density gauges is designed to measure and control the bulk density of solid materials. The measuring head is located directly above the material on the conveyor belt (Fig. 1). The electronics and recorder/controller can be located at some distance from the head if this is so desired. The scraper bar seen on the right is used to rough-level the material on the conveyor belt before it is measured. The measuring head is also available as a long, cylindrical probe which can be inserted directly into the contents of a bin or hopper. Model 504 is used to measure and

Fig. 3.—Model 507 bulk density gauge for solid materials. The measuring head can be fitted for conveyor operation (as shown here) or for materials in bins



control the specific gravity of solutions and slurries in pipes or tanks (*see* Fig. 2).

Model 507 enables measurement and control of solid materials on a belt or in a storage facility to be carried out expeditely. The measuring head is available in two designs. One of these is used for operation in connection with conveyor belts (*see* Fig. 3), while the other is for materials contained in storage bins. In each case the percentage of moisture in the material can be read out directly.

Model 509 is applied to the percentage of moisture of liquids or slurries in a process loop or in a tank. This Model 509 fluid moisture system for liquids and slurries is shown in Fig. 4. The measuring head is located in the top tank which is installed at the proper measurement point in the process system. The bottom tank is used for standardization. Transistorized instrument rack seen at the right may be located at any distance from the measuring head. The measurement is read off as percentage moisture by weight. Data presentation in this system is in the form of direct numerical print-out on paper. Analogue presentation is also available if required. The systems 502, 507 and 509 are exclusive to Nuclear Chicago, and are the first systems of their type ever made in America for commercial availability.

Each instrument, it will be seen, consists of three basic parts: the measuring head, the electronic read-out, and the recorder/controller which displays the desired information and controls the measured variable. Each system can be provided with either analogue or digital data presentation and control. The four systems are all based on the use of nuclear radiations. Those systems which are involved in the measurement of density make use of reflection and transmission of gamma radiations, while the systems concerned with moisture are based on the principle of neutron reflection. Each system is designed for complete safety. Merchandizing and sales programmes for these systems have been worked out in detail and will be organized through the company's own established sales offices.

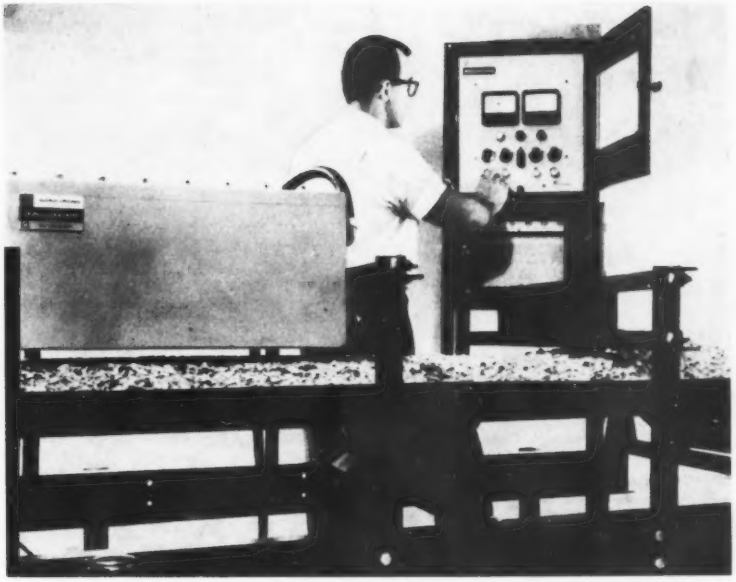


Fig. 4.—Model 509 fluid moisture system for liquids and slurries is shown here. The measuring head is in the top tank, the bottom tank being for standardization. On the right is the transistorized instrument rack

Monographs and translations received

The Deposition of Fission Products from Distant Nuclear Test Explosions, Results to the Middle of 1960, by R. N. Crooks, R. G. D. Osmond, Miss E. M. R. Fisher, M. J. Owers and T. W. Evett. Published by AERE Harwell. Reference AERE—R 3349. Available from H.M. Stationery Office. Price 2*s.* 6*d.*

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Experiments on the Determination of the Maximum and Minimum Values of the Heat Transferred between a Metal Surface and Boiling Water, by S. Nukiyama, translated by S. G. Brickley. Available from the Library, AERE, Harwell. Reference AERE-Trans 854.

Classroom and Laboratory

Arising out of a proposal by Dr. F. R. Paulsen, at a Council Meeting of the Institution of Nuclear Engineers, several hundred teachers of nuclear science were asked to report on simple apparatus and methods used or those which might be useful for practical demonstrations in instructional courses. The response was enthusiastic. From all parts of the world, from teachers in Universities, High Schools and Colleges, from research workers, manufacturers and public relations experts, have come many ideas. As a service to teachers, and also to other workers in nuclear fields, we are now commencing publication of the many suggestions put forward. Each suggestion will carry the identity of the person who put it forward, and also a reference number. The latter will facilitate enquiries sent in by readers wishing for further information. Readers are invited to submit suggestions for inclusion in this feature

No. 1 A thorium-234 "Cow"

D. J. Carswell and J. J. Lawrence, Australia.

Thorium-234, obtainable from natural uranium compounds, and with a half-life of 24.1 days, is very suitable for college and university course work. Its decay product, Pa234, with a half-life of 1.18 min, is also invaluable for the measurement of half-lives and the plotting of decay-curves. For these purposes, if the exercise is to be completed within a normal class period, there are no convenient nuclides obtainable on the market.

The specific activity of U-238 is 3.36×10^{-7} curie/gm, and the decay rate 7.4×10^5 disintegrations/min/gm. At equilibrium, the activity due to Th234 will equal that due to the parent U-238. Now 50 per cent. of the equilibrium concentration is reached after one daughter lifetime, and a semi-continuous supply of Th234 can be "milked" from natural uranium salts, monthly "milkings" providing 4×10^5 disintegrations/min of Th234 per 1 gm of U-238.

Ion exchange offers a good method of extraction, and this has been applied to both a small column and a large column.

For the small column a 50 ml burette with detachable plastic diaphragm stopcock and tip is used. A plug of glasswool is placed in the lower end, and above it 50 ml of Deacidite FF (manufactured by Permutit Co., Ltd.) or Dowex 1 (Dow Chemical Co.), of 16-50 mesh. A second glasswool plug is placed on top of the resin bed, which is then conditioned to the chloride form. Through the bed are then passed in turn two column volumes of 7M HCl and uranyl chloride in 7M HCl (0.0986 gm U/ml). at a flow rate of six drops/min, until breakthrough occurs (about 73 ml). Four column volumes of 8M HCl are passed through, and the combined effluent is analysed for uranium, giving the capacity of the bed (about 6.5 gm). After a month, the Th234 is eluted with 50 ml of 8M HCl containing 1 mg of Th232, and concentrated on a small ZeoKarb 225 (Permutit) or Dowex 50 (Dow) column of capacity about 1 ml. The thorium is then eluted with oxalic acid solution. The oxalate can be destroyed by nitric acid and hydrogen peroxide to give a Th234 solution in HNO_3 suitable for tracer work.

In a later issue a modification of this Th234 "cow," with a greater capacity and suitable for preparation of Pa234, will be described.

No. 2 Separation of cerium-144 from praseodymium-144

Arthur Bradley and Michael Adamowicz, U.S.A.

Ce144, one of the predominating fission products from U-235, is readily accessible, and with a half-life of 285 days it decays to Pr144, the half-life of which is 17 min. The amount of activity handled in this experiment is only about 1 microcurie, or 2.2×10^6 disintegrations/min of each nuclide, so that no hazard is involved. As the Pr144 is separated from the Ce144, the latter decays to yield more Ce144. In one hour, 90 per cent. or more of the equilibrium concentration of Pr144 is formed, and the experiment can then be repeated. It is possible, then, to have the Pr144 disintegrating to zero count during one class period, yet still available for the next period.

To 17 mg of ceric ammonium sulphate in 5 ml of 5N HNO_3 is added 1 microcurie of the Ce(Pr)144 tracer solution and then 1 ml of solution containing 9 mg of $PrCl_3$/ml (or another rare earth other than cerium). Now 1 ml of 1N $NaBrO_3$ is added, and the mixture is kept at 50-70°C. for 5 min. The Ce is oxidized to the ceric state. The solution is cooled in ice for 2-3 min, and 4 ml of saturated $NaIO_3$ added. The mixture is left in ice for a further 3 min to complete separation of the $Ce(IO_3)_4$, then filtered on a fluted paper. The precipitate is washed twice with 1-2 ml of water, and the clear filtrate collected. The filtrate is counted at 3-min intervals for about an hour in a liquid GM counter, and from the plot of activity against time the half-life of the Pr144 is determined.

The $Ce(IO_3)_4$ precipitate is washed from the paper into a beaker and dissolved in 10 ml of 3 per cent. H_2O_2 and 5 ml of 5N HNO_3. The solution is evaporated on the steam-bath to dryness, taken up in 5N HNO_3 and is then ready for recycling for the separation of the Pr144, except that this time no cerium carrier need be added.

No. 3 Electrolysis of a thorium solution

Clyde R. Dillard and Linwood Morton, U.S.A.

In this experiment Pb212 and Bi212 are separated from thorium by electrolysis. Since short-lived activities must be handled without any delay, planning of the procedures is necessary, and all contamination by longlived species must be avoided. Apparatus must be assembled ready for use, and all pieces of equipment, after use, must be disposed of in such a way that they are known to be possible sources of contamination. The equipment required is as follows: 30-ml platinum crucible, platinum foil anode, ammeter (0-2.5 amp), four 1.5v dry cells, rheostat, a wide-mouthed bottle labelled "thorium washings" and another "electrolyzed thorium," centrifuge tubes, planchets, infra-red heating lamp. Also required are the following reagents: 0.5M $Th(NO_3)_4$ in 0.1M HNO_3, 0.1N $Bi(NO_3)_3$, 0.1N $Pb(NO_3)_2$, 0.1M H_2SO_4, and concentrated H_2SO_4, HNO_3 and NH_4OH.

A crocodile clip connects the platinum crucible to the rheostat, which is in series with the ammeter and cells (6v total), and the platinum anode. The crucible holds 20 ml of 0.5 $Th(NO_3)_4$ solution, and the current is adjusted to 0.1 amp. After electrolysis for 5-10 min, the anode is removed and rinsed into the " thorium rinsings " bottle, while the main solution goes into the " electrolysed thorium " bottle, which is dated. Several rinsings of the crucible are made and transferred to the " rinsings " bottle. One ml of concentrated HNO_3 is boiled in the crucible and swirled around to dissolve the Bi and Pb.

A count is now made on a portion of the carrier-free Bi and Pb solution by neutralizing with ammonia solution, evaporating on a planchet under the lamp, counting, and plotting the decay curve. From this plot the half-lives of the Pb212 and Bi212 may be determined (these are 10.6 hr and 1.0 hr respectively).

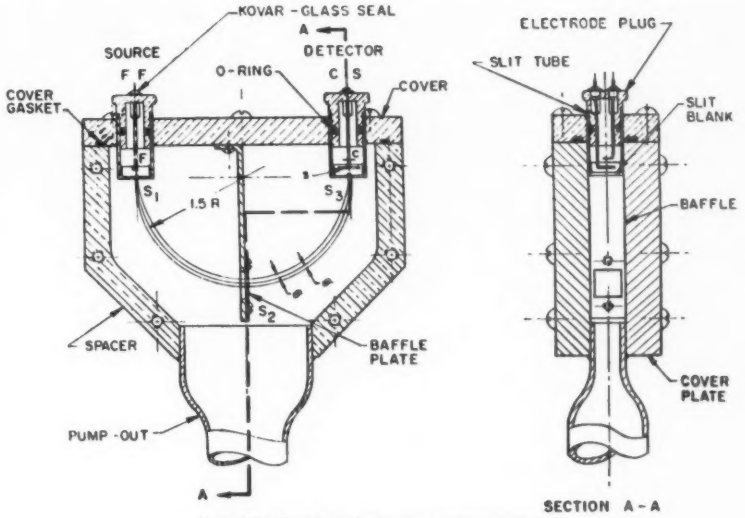
To the HNO_3 solution are now added 1 ml of 0.1N $Pb(NO_3)_2$, 1 ml of 0.1N $Bi(NO_3)_3$ and six drops of concentrated H_2SO_4. This mixture is carefully fumed down, then diluted with 1 ml of water and transferred to a centrifuge tube, the precipitate being washed in with 0.1M H_2SO_4. After centrifuging, the supernatant is decanted and reserved for the plotting of the Bi decay curve.

The precipitate is washed with 0.1M H_2SO_4, then dissolved in a few drops of concentrated HNO_3, transferred to a planchet, evaporated and counted, to give the decay curve for the Pb nuclide. The Bi portion is made alkaline with ammonia solution, centrifuged, and the precipitate is washed, dissolved in concentrated HNO_3, transferred to a planchet, evaporated and counted. In this way the Bi decay curve is plotted.

No. 4 Small mass spectrometer

Robert G. Marcley, U.S.A.

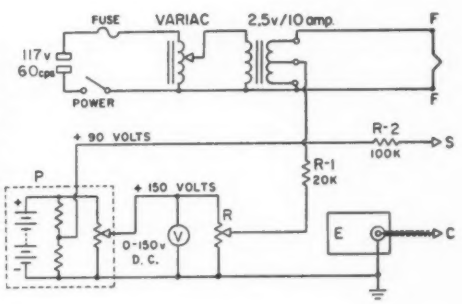
In this very simple, small-radius, 180° mass spectrometer, the ion source is a tungsten filament coated with a salt of the element to be investigated. With Li7, a magnetic field of 1,000 gauss, and an accelerating potential of 100v, a detector current of 10^{-11} amp is obtained, the resolving power being 33.



Assembly drawing of the mass spectrometer

The vacuum chamber consists of two annealed mild steel plates, degreased and hard-soldered to a brass spacer. The assembly is heated up slowly and evenly, and solder applied from the inside of the chamber, so that a solid fillet of solder isolates any flux, trapped between the covers and the spacer, from the evacuated region. The assembly is cooled, washed and scrubbed clean. The cover plates are used as pole pieces, and give a reasonably uniform magnetic field derived from an electromagnet or small magnetron magnet. The field is preferably over 1,000 gauss. If the pole pieces are 2 in. diameter or less, large tapered transition pieces are used to separate the cover plates from the magnet. The end cover of the chamber is a brass plate carrying the filament, slits and detector, with a neoprene gasket. The chamber is evacuated through a tube soldered into place and squeezed flat between the plates. The pump-out port and the spacer may be milled and shaped, or drilled and filed to shape. A good soldering flux consists of 71 per cent. by weight of $ZnCl_2$ and 29 per cent. of HN_4Cl, just enough water being used to ensure solution, which is then diluted 1:5 or 1:10 with water for use. The soft solder should be free from cadmium, the high vapour pressure of which would result in grave contamination of the vacuum system. The pump-out tube should be annealed before being squeezed.

The slits S_1 and S_2 are in tubes soldered to the cover plate. Slit S_2 is a rectangular window in a brass strip screwed to the cover. The filament, a short length of 0.005 in. diameter tungsten wire, is mounted on a plug fitting into the slit tube and sealed by an O-ring. The detector is a small collector plate and ring biased to repel low energy ions,



Control and measuring circuits. *F-F* is the filament, *C* the ion-collector plate, and *S* the repeller ring connections. *P* is the power supply—150v minimum—regulated if possible. *R* is a 10 turn 10,000-to 50,000-ohm 5w potentiometer, 0.25 per cent. linearity. *E* is an electrometer with a full scale sensitivity of 10^{-11} amperes and an input resistance of 10^{10} and 10^{11} ohms. *R*-1 and *R*-2 are protective resistors

also mounted with an O-ring. The electrical connections to the detector and filament are through Kovar-Glass solder terminals. The collector current produces across a high resistance a voltage drop which is measured by an electrometer. Depending on ion emission, the resistance will be between 10^{10} and 10^{11} ohms. A fibre-, quadrant- or vacuum-tube electrometer is suitable. A stable, filtered power supply and adjustable voltage divider provide the accelerating voltage and a 10-turn potentiometer, reading 10,000 to 50,000 ohms, is satisfactory. The vacuum is produced by a 4.5 litre/sec two-stage, fractionating oil-diffusion pump giving a pressure of 5×10^{-6} mm Hg, a baffle preventing excessive entry of oil. The effects of sudden entry of air can be minimized by the use of a suitable silicone pump fluid, a Penning discharge gauge (Phillips gauge), and a thoriated iridium filament ionization gauge. As ion source, powdered spodumene can be mixed with adhesive and painted on to the filament. Lithium sulphate and KCl may also be used, in the form of a strong solution.

The cover plates are each $4\frac{1}{2}$ in. $\times$ 3 in. $\times \frac{1}{2}$ in., of cold rolled steel; the spacer is $4\frac{1}{2}$ in. $\times$ 3 in. $\times \frac{1}{2}$ in. brass; the pump-out tube $1\frac{1}{2}$ in. diameter with $^1/_{16}$ in. wall, tubing being of brass or copper; the cover is $4\frac{1}{2}$ in. $\times 1\frac{1}{2}$ in. $\times \frac{3}{8}$ in. brass; cover gasket, $4\frac{1}{8}$ in. $\times \frac{7}{8}$ in. $\times$ $^1/_{16}$ in. neoprene ; slit tubes $\frac{1}{2}$ in. o.d., $\frac{7}{8}$ in. long, brass; slit blanks, $\frac{1}{2}$ in. o.d., $^3/_{16}$ in. brass; electrode plug, $\frac{5}{8}$ in. $\times \frac{3}{4}$ in. brass; baffle, $2\frac{7}{8}$ in. $\times \frac{1}{2}$ in. $\times$ $^1/_{32}$ in. brass; baffle plate, 1 in. $\times \frac{1}{2}$ in. $\times$ $^1/_{32}$ brass (one off), O-rings (two off) $^7/_{16}$ in. $\times$ $^5/_{16}$ in. i.d. $\times$ $^1/_{16}$ in., and four off No. 95-0053 Kovar-Glass seal. There is also needed a range of wires, tungsten, 0.005 in. diameter; tantalum, nichrome V, etc., 0.01-0.03 in., and tantalum, nichrome V, etc., sheet 0.005-0.010 in. thick, and tantalum, nichrome V, etc., rod, 0.040 in. diameter.

No. 5 Study of the thiosulphate ion

Whittie J. McCool and Robert R. Hentz, U.S.A.

Sulphur-35 is obtainable fairly readily, and the AEC, for example, supplies it in the form of the element, as BaS, and H_2SO_4. Since the energy of the beta emission is only 0.17 MeV, it is quite suitable for work with little shielding. A capsule of high-activity S from the AEC is broken into a 500 ml flask and the benzene evaporated off. The radio-S is now dissolved in 50 ml of alcohol containing 14 mg of alcohol-soluble carrier sulphur. A check count is made on a small aliquot, after solvent evaporation, using a thin-window counter. Aliquots are diluted with 5 gm of CS_2-soluble carrier S, to give specific activity of 0.8 microcurie. About 500 mg of this diluted S is weighed into a sample planchet, melted, solidified and counted, then remelted, recooled and recounted. Now 400 mg are weighed into a 250 ml conical flask, dissolved in 20 ml of CS_2 and reprecipitated with acetone. The supernatant solvent is removed, the S washed with water, then treated with 100 ml of 0.24M Na_2SO_3, and boiled until the S is all dissolved. Care must be taken to exclude air, and a Bunsen valve should be used. The flask is now fitted with a three-holed rubber bung. One hole carries a tube with a sintered glass plug to act as vent; through another hole passes the end of a burette charged with 2N HCl; the third hole carries an exit tube connected to a washbottle containing saturated baryta solution, and an aspirator. About 15 ml of the 2N HCl are slowly added, the system being aspirated. Finally, with the burette replaced by a thermometer, aspiration is continued for an hour at 75°C. The $BaSO_3$ precipitate is digested on the steambath for half an hour, washed by decantation, mounted, evaporated and counted. The S precipitate in the flask is washed, melted in a planchet, cooled, and counted. The $BaSO_3$ is found to carry negligible activity, the original S activity being found entirely in the S precipitate. This indicates non-equivalence and non-exchange of the two S atoms in the thiosulphate ion, the S atom taken up by the sulphite being the same one as is liberated on acidification. This may be shown by the equations:

$$*S + SO_3'' \rightarrow (*S - SO_3)''$$
$$+ 2H^+ \rightarrow H_2O + SO_2 + *S$$

No. 6 Sources for class use

D. J. Carswell, Australia.

As sources suitable for class use the following are recommended:

(*a*) Alpha source: either Th230 or U-233 prepared as a thin film on a 1 in. diameter stainless steel planchet, sealed to the surface by an oxide film. The strength of the source is generally 0.01 to 0.1 microcurie.

(*b*) Beta source: Epoxy resin impregnated with uranium oxide is cast in a 1 in. diameter aluminium planchet, the activity being 0.02 to 0.2 microcurie. A Cs137 source of similar strength evaporated from a solution on a planchet and sealed in with " Estapol " is a second choice.

(*c*) Gamma source: Epoxy resin impregnated with Co60 in the form of its oxide is cast in a 1 in. aluminium planchet, the activity being 0.5 to 5 microcuries. For experiments on the inverse square law, a special epoxy resin-cobalt oxide source is used, mounted in a $\frac{1}{4}$ in. diameter aluminium capsule on an aluminium rod. This source should have an activity of 0.5 to 5 microcuries.

No. 7 Thermal diffusion process

F. R. Paulsen, U.K.

The principle of isotope separation by thermal diffusion, sometimes known as the Clusius-Dickel technique, may be illustrated as follows: By means of suitable corks or rubber bungs, a $2\frac{1}{2}$ m $\times$ 1 cm Pyrex tube is arranged concentrically within a Pyrex tube of the same length, but twice the diameter. The annular space is filled with a 5 per cent. solution of copper sulphate. Steam is passed through the centre tube, while the outer tube is cooled by a current of cold water passing down the outside. After a few hours there is a clear concentration of copper in the lower part of the tube, the liquid in the upper part being of much paler colour. This is not actually an isotope separation, of course, but illustrates the principle of the method.

No. 8 Thermal diffusion process

Juan A. McMillan, U.S.A.

The Clusius-Dickel technique may also be illustrated conveniently by the following method. A 0.1 mm diameter platinum wire runs centrally down a vertical glass tube 50 cm long and 8 mm inside diameter. A 1 gm Pyrex weight sealed about 5 cm from the lower end of the

wire will ensure that the hot wire remains taut and straight. The apparatus is filled with air saturated with bromine. An a.c. heating current of 25v potential difference and 1 amp results in the separation of bromine and air at once, and in a few minutes the top of the gas column becomes colourless. Because of thermal conductivity differences, the bottom part of the wire becomes red. Continued heating results in condensation of bromine in the cold lower end.

No. 9 Accelerator model

Professor Dr.-Ing. E. Menzel, Germany.

In this model, which demonstrates the acceleration of charged particles under the influence of an electric potential, the particle is represented by a table-tennis ball coated with silver and resting in a horizontal V-groove made from some insulating plastic. The groove is attached at one end to a circular metal plate (*A*) and at the other end to a similar plate (*B*) having a circular hole through which the ball can pass. Plate *B* is earthed, while plate *A* is connected to a small Van de Graaf generator. When the latter is switched on, the ball is set in motion by the field between the two plates, and is shot through the hole in plate *B*.

No. 10 Radioactivation experiment

C. G. Wilson, U.K.

A small neutron source (a 20 mg Ra-Be source) is placed in a central hole in a block of wax, to thermalize the neutrons. Two silver coins, one pre-1920, the other post-1920, are mounted in slots in the wax a few cm from the source. After 5 min irradiation, the two coins are removed and placed under a GM counter, giving aural or visual indication. Only the older coin emits beta radiation, the result of radioactivation of the silver in the alloy. After 1920, " silver " coins no longer contained this metal.

No. 11 Thermalization of neutrons

C. G. Wilson, U.K.

The small neutron source (*see* No. 10) is contained in a beaker. A fast neutron monitor outside the beaker registers a steady count rate, while a neighbouring slow neutron counter (of the BF_3 proportional type) records only a slow count. Water is poured into the beaker. The slow neutron count rate increases, while the count rate of fast neutrons is diminished.

No. 12 Measuring concentrations by radiations

Société d'Applications Industrielles de la Physique, France.

A glass cell with parallel sides is used to hold a fixed volume of a solution at various concentrations. Anhydrous sodium sulphite is suggested as a suitable salt to use. One side of the cell is brought close to the GM counter, while against the other wall is placed a 100 microcurie source of Cs137. The count rate is plotted against the concentration of the solution, and the plot is linear over the range 0 to 85 p.p.m. Unknown concentrations can be determined from the graph when the count rate has been determined.

No. 13 A simple electroscope

George A. Scherer, U.S.A.

This simple electroscope is readily made from easily-available materials. The case is made from a wooden chalk box, the sliding wooden lid of which is replaced by a piece of window glass. The box stands on one end. Through the other end, now the top, passes a brass rod terminating at the top in a metal knob. The lower end of the rod is flattened, drilled and fitted with a cardboard quadrant bearing a scale, and a piece of thin aluminium foil 1 cm × 4.5 cm. The $\frac{3}{4}$ in. hole through which the copper rod passes is filled with molten sulphur. The electroscope is charged by touching the metal knob with a stick of sealing wax rubbed on a woollen cloth. The time for discharge between any two divisions on the scale is noted, and this "natural" rate of discharge is subtracted from that observed when a radioactive material is placed in the bottom of the box. Discharge rate is found to depend on the area exposed by a given radioactive material, rather than on the weight of the material.

No. 14 Separation of thorium from uranium

Charles A. Brown and E. G. Rochow, U.S.A.

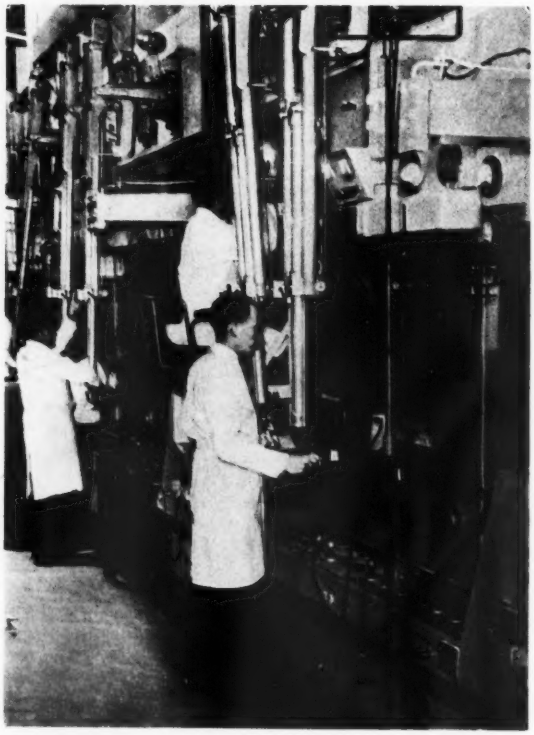
The activity of a 1 g sample of uranyl sulphate is checked on the G.M. counter. The salt is dissolved in 10 ml of water and three drops of 0.1 M ferric chloride added, followed by 2 ml of dilute ammonia solution and then solid potassium carbonate until the bright yellow precipitate just redissolves. The mixture is filtered on a small paper circle on a suction filter, and the activity of the precipitate tested. The intense activity can be shown to be due to beta particles by interposing absorbing sheets of aluminium and lead. Crystalline uranyl acetate can be recovered from the filtrate by adding solid potassium acetate, the crystals being collected. They are found to have little of the original activity observed in the original sample.

No. 15 A simple radiation attenuation disc

F. R. Paulsen, U.K.

A number of 1 in. diameter holes are cut into a 12 in. diameter disc of stout cardboard, quite close to its periphery. The holes are closed by 1 mm thicknesses of various materials, so that each hole bears a different absorbing substance. Suitable materials are: mica, lead, tin, aluminium, iron, nickel, zinc, glass, polythene, paper, rubber and copper, although many others are possible. The circular sheet is glued to a cork through the centre of which passes a very small test-tube, so that the disc may be made to rest on a short length of glass rod fitting into the tube and itself mounted in a block of wood. By placing a radioactive source below the disc, close to the edge, and a G.M. counter immediately above it and above the disc, the disc may be made to rotate so that the various materials in turn are brought as absorbing substances to cut off radiations. In this way the absorbing properties of the materials may be compared. By a slight variation of this idea, using several thicknesses of the same material mounted on a single disc, the energies of radiations and the half-thicknesses for various materials may be determined.

Remote Handling Cells For Australian Research



Exterior view of the Lucas Heights "hot cells"

FOUR remotely-controlled " hot " cells recently went into operation at the Australian Atomic Energy Commission's research establishment at Lucas Heights, near Sydney, New South Wales.

Designed by engineers and metallurgists at the research establishment and built by local contractors under the supervision of an Australian firm of Consulting Engineers, at a cost of nearly £A500,000, they have greatly increased Australian facilities for conducting nuclear experiments and for the development of the science and technology of nuclear materials generally.

The cells are equipped with a comprehensive range of remote handling equipment, master-slave manipulators and other tools necessary for the machining and metal work to be carried out on materials which come from a high neutron flux in the establishment's research reactor, HIFAR (High Flux Australian Reactor).

Essential

The cells and their equipment are essential for experimental irradiation tests on nuclear materials such as uranium, thorium, beryllium and their compounds; to facilitate a wide variety of operations including dismantling rigs from HIFAR and for making a detailed study of their contents, inspection and maintenance of parts of the reactor core and the handling and packaging of high-activity isotopes.

They will also be used for handling special experiments carried out in HIFAR for outside organizations. Experiments are being undertaken under contract with the United Kingdom Atomic Energy Authority and with the General Electric Co. Some small radiation tests are also being made for Australian universities.

The present in-line arrangement of the four cells is a high-activity cell for 100,000 MeV curies, and three medium-activity cells to handle 1,000 MeV curies. The high-activity cell has two solid lead glass windows, 3 ft 6 in. thick, of high-density lead glass and the medium-activity cells, composite zinc bromide windows with lead glass panes. The inner panes of all windows are cerium stabilized irradiation resistant glass.

The medium-activity cells are 6 ft wide—cell No. 2 is 10 ft long and cells Nos. 3 and 4, 8 ft. No. 1—the high-activity cell—is 10 ft in length. all cells have 3 ft 6 in. thick steel and concrete walls. They are virtually a series of laboratories in which the high-density lead glass windows are necessary to give the operator a visual sighting of the cells and protect him from radiation.

Closed Circuit Television

No. 1 cell will be used for primary breakdown of irradiation experiments and sample extraction; No. 2 for the mechanical and physical examination of irradiated materials—hardness, density, tensile properties, metrology, stereo-photography, thermal conductivity; No. 3 for chemical studies—dissolving and fission product separation; No. 4 for metallographic preparation. A remote-controlled metallographic microscope, built into the wall of this cell with a screening of lead 6 in. thick, will operate on the periscope principle enabling a detailed close-up view of samples. Closed circuit television will be used in the cells.

Special Cells built later

The Atomic Energy Commission expects later to build further special purpose cells which will be added to the present block. They will be designed according to experience gained in working the existing cells, and their importance will be in relation to the materials to be handled from HIFAR as the experimental programme is expanded.

These materials and their behaviour, after long-term residence in the reactor, are key factors in the research programme of developing fuel elements to operate at high temperatures to obtain a high burn-up of uranium content with a minimum of irradiation damage.

THE INSTITUTION OF NUCLEAR ENGINEERS

January Council Meeting

MIDLAND BRANCH FORMED

Institution Conference Planned

THE Birmingham branch mentioned in the January issue of NUCLEAR ENERGY has been formed by Mr. H. J. Jones and is to be known as the Midland Branch. The first meeting of this Branch is to be held on March 28th in Assembly Room G7 of the Birmingham College of Advanced Technology, Gosta Green, Birmingham, from 7-8.30 p.m.

Conference Committee

Mr. Spear suggested that a conference should be held later this year on the subject of " Cleaning, preservation and packing of nuclear equipment." This suggestion was unanimously accepted by the Council and a conference committee consisting of Mr. Spear and Mr. J. C. Bradbury-Williams was formed.

Educational Committee

The Secretary reported to the January Council Meeting that a number of papers had been submitted for presentation at Institution meetings. It was agreed that an educational committee be formed, consisting of Dr. Paulsen and Dr. Grassam, with the object of "vetting" these papers. Additional members can be co-opted when required.

NEW MEMBERS

Elected 9th December, 1960

V. S. Balmforth, M, Castle Donington.
B. Burton, A, Romford, Essex.
R. A. Davies, A, Frodsham, Cheshire.
D. K. Dickinson, A, Castle Donington.
M. P. Fretwell, SM, Hayes, Middx.
P. V. Gilli, M, Weymouth, Dorset.
A. Halliwell, A, Bolton, Lancs.
D. T. Hawkings, A, Basingstoke, Hampshire.
E. A. Hawkins, M, Maidenhead, Berks.
G. O. Hermansson, M, Stockholm.
L. A. Hicks, A, Barnet, Herts.
E. C. Jackson, M, Kingsbury, London.
V. H. Jackson, A, Erdington, Birmingham.
A. E. Jones, A, Manchester.
I. Lewis, A, Holyhead, Anglesey.
D. R. Morris, M, Winchmore Hill, London.
A. Parkinson, A, Warrington, Lancs.
F. Rieband, M, Solihull, Warwickshire.
P. W. Smart, A, Brownhills, Staffs.
F. Spencer, A, Shirland, Derbyshire.

Elected 11th December, 1960

I. G. Ansell, A, Luton, Beds.
N. Ashton, A, Alvaston, Derby.
D. Bailey, A, Bracknell, Berks.
D. W. Bartlett, A, Mickleover, Derby.
S. J. Bray, A, Maghull, Lancs.
M. A. Cockburn, A, Annan, Dumfriesshire.
A. Cleveland, M, Knutsford, Cheshire.
B. D. Dear, A, Hendon, London.
I. C. Forbes, JM, Dorchester, Dorset.
J. F. Hendrie, A, Flackwell Heath, Bucks.
N. W. Hodges, M, Bristol, Glos.
P. R. Holloway, A, Worcester Park, Surrey.
D. C. H. Hull, M, Ipswich, Suffolk.
E. J. Marsden, A, Derby.
J. C. MacFarlane, A, Annan, Dumfriesshire.
W. MacFarlane, M, Hamilton, Lanarkshire.
A. W. Nicklin, M, Warrington, Lancs.
H. S. G. Smith, M, London.
R. L. Stevenson, M, Bracknell, Berks.
G. L. Thomson, A, Annan, Dumfriesshire.
G. H. Walker, A, Wantage, Berks.

Elected 14th October, 1960

Ismet Aktekin, A, Knutsford, Cheshire.
P. F. Beaver, M, Newbury, Berks.
J. G. Briginshaw, A, Surbiton, Surrey.
J. R. Brimson, M, Sutton Coldfield.
W. G. S. Castle, A, Mickleover, Derby.
Ivan Collins, A, Streatley, Luton.
D. A. Cooknell, A, Birmingham.
R. Craig, M, Bridgwater, Somerset.
E. W. Davey, A, Baughurst, Hants.
C. J. V. Davies, A, London.
R. E. Dewhirst, M, Saltcoats, Ayrshire.
S. J. Green, A, Weymouth, Dorset.
B. F. Halesworth, A, Castle Donington.
D. H. Haywood, M, Culcheth, Lancs.
N. L. Higgs, A, Castle Donington.
K. H. Hughes, A, Reading, Berks.
S. H. B. Hutchinson, A, Slough, Bucks.
R. A. Javitch, A, Quebec, Canada.
E. Jones, M, Oaklands, Bridgend.
G. M. Kennelly, JM, Canada.
J. R. Leach, M, Byfleet, Surrey.
D. Lennard, A, Southminster, Essex.
J. A. Marsh, A, Thames Ditton, Surrey.
R. W. F. Paul, A, Hampshire.
B. F. Pring, A, Somerset.
A. C. Robinson, A, Slough, Bucks.
N. W. Shaw, M, Westcliff-on-Sea, Essex.
C. E. Stille, M, London.
T. G. Swain, A, Spondon, Derby.
B. W. Taylor, A, Kidwelly, Carms.
B. Tidder, M, Kirby Muxloe, Leics.
J. E. Waller, A, St. Albans, Herts.
J. D. Wood, A, Northants.
J. H. Woodward, A, Dunbartonshire.
B. Wright, A, Redbourn, Herts.
E. H. Yeo, M, Aldermaston, Berks.

A Ceremony at the Embassy

Sir John receives his Gold Medal from the Italian Ambassador Count Zoppi first Hon.M.I.Nuc.E.

(*Above*) **Count Zoppi (*left*) talking to J. B. Pinkerton (*right*)**

(*Top, left*) **Gold Medal being presented to Sir John Duncanson by Count Zoppi**

(*Left*) **People at the Presentation. *Left to right*: A. E. Merrin, F. L. Coombs, Dr. W. J. Jenkins, Clemente Boniver, Count Zoppi, A. E. Wyatt, Sir John Duncanson, D. S. Watt, H. E. Cooper, J. B. Pinkerton, Dr. N. S. Grassam, J. C. Bradbury-Williams, H. J. Winch**

HIS Excellency Count Zoppi, the Italian Ambassador, presented Sir John Duncanson with the Gold Medal "Scientia et Divulgatio," which was awarded to the President of the Institution of Nuclear Engineers by the Rassegna Internazionale Elettronicae Nucleare.

The ceremony took place at the Italian Embassy in London, in the presence of members of the Council of the Institution.

In making the presentation, Count Zoppi said the Rassegna Internazionale was, like the Institution of Nuclear Engineers, a young but fast-growing organization. It operated under the patronage of the Italian Government and gathered together prominent men of science and industrialists in electronics and nuclear engineering. The Congress which the Rassegna held every year served a very useful purpose in promoting the exchange of findings in these important fields, and each year a gold medal "Scientia et Divulgatio" was awarded to a scientist or a prominent personality who had distinguished himself in the field of nuclear and electronics engineering.

"It is with pleasure that I have learnt that the 7th Congress gold medal has been awarded to Sir John Duncanson—President of the Institution of Nuclear Engineers—for his outstanding work in this field. I won't go into Sir John's many activities which also include shipbuilding, banking, and research, as I am sure you are all better acquainted with them than I. Allow me to mention only that Sir John is already well-known in Italy, in his capacity as adviser to the late Mr. Ernest Bevin for the recovery of Europe after the war; he did admirable work and came into close contact with my country."

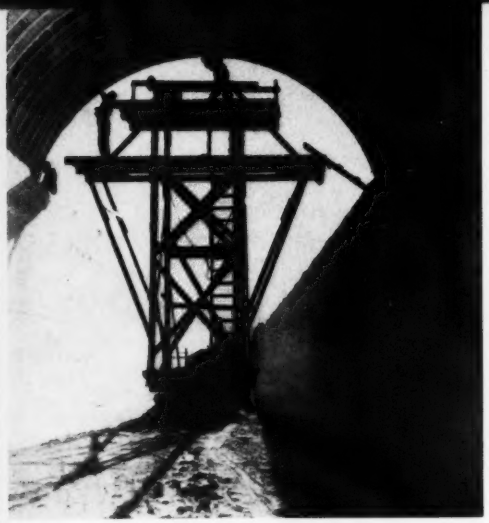
The President made an appropriate reply and outlined the rise of the Institution.

After the ceremony it was announced that His Excellency the Ambassador had agreed to become the Institution's first Honorary Member.

(*Top, left to right*) **Clemente Boniver, Sir John Duncanson and Dr. W. J. Jenkins**

(*Middle, left to right*) **A. E. Merrin, H. E. Cooper and J. B. Pinkerton**

(*Right, left to right*) **Count Zoppi, A. E. Wyatt, F. L. Coombs, A. E. Merrin and D. S. Watt**



(*Left*) A work crew putting the roof of corrugated metal forms on a tunnel. It is in this tunnel that the nuclear reactor is housed

(*Right*) When the tunnel has been completed it is covered with a blanket of snow by a Peter Snow Miller. This machine "processes" the snow, making it coarser and harder. In a very short time it freezes into a solid roof

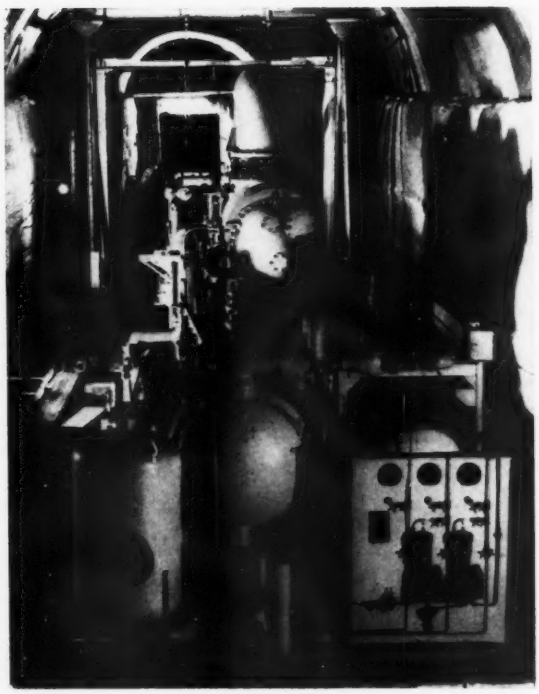
NUCLEAR CAMP IN ICE

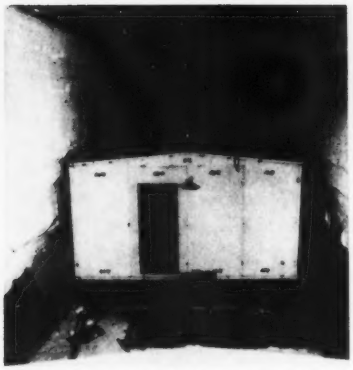
American Arctic Achievement

(*Left*) One of the circular hatchway entrances to Camp Century which project above the snowfield

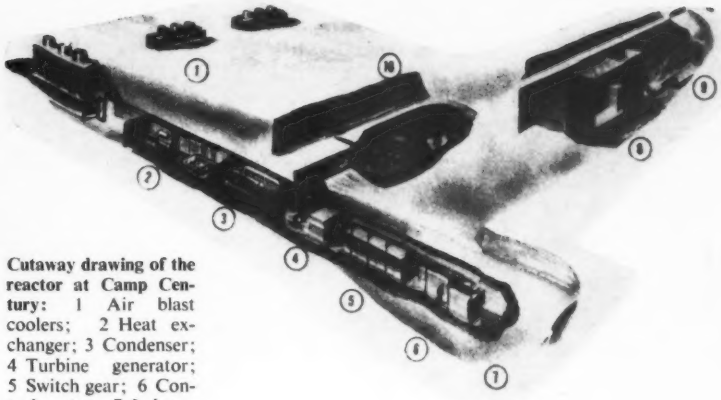
(*Bottom, left*) One of the original trenches being dug by snowploughs at Camp Century. The temporary work camp erected can be seen in the background

(*Right*) The reactor installed at Camp Century to provide heat, light and power





One of the prefabricated wooden buildings erected inside the tunnels of Camp Century



Cutaway drawing of the reactor at Camp Century: 1 Air blast coolers; 2 Heat exchanger; 3 Condenser; 4 Turbine generator; 5 Switch gear; 6 Control centre; 7 Laboratory; 8 Reactor; 9 Hot waste tank; 10 Feedwater

SURELY the camp built by United States Army engineers in Greenland to house 100 scientists and technicians must be one of the most unusual on earth. Camp Century as it is known is in fact a scientific research laboratory built in Greenland by agreement between the U.S. and Danish governments to study weather conditions in this, one of the most severe climates on earth. Previously research in this area, which is the starting point of weather for much of the Northern Hemisphere, has been limited to the five summer months. However, in future scientists in this camp can live and work in comfort all the year round thanks to the advent of nuclear power. The source of all heat, light and power in Camp Century is a 2,000 kW PM2-A reactor. To eliminate the effect of the severe storms common in this district, Camp Century has been built in tunnels in the icecap, altogether there are 21 of them with 30 prefabricated wooden buildings inside. These buildings include research laboratories, living quarters, and the atomic power plant. Entrance to the camp is via huge doors at either end of the main tunnel, with escape hatches provided in case of emergencies. Until now the problem of supplying heat and power to scientists carrying out research in the Arctic has been a most difficult problem. The use of a reactor eliminates the need to transport large quantities of fuel oil across the icecap and enables a really effective research programme to be undertaken. The PM2-A reactor will operate for a year with a single loading of fuel. The research programme at Camp Century is aimed at establishing the weather history of the region and with the aid of this information it is hoped that accurate predictions on future weather cycles will be possible. Tests are also being carried out to develop a reliable method for detecting hidden crevices. By 1962 a similar establishment will be operating as a base at McMurdo Sound for the American Antarctic research programme.

(*Below*) **Corrugated metal forms for the tunnel roofs being placed in position**

(*Right*) **Control console of the PM2-A reactor**

REACTOR STEELS

British Nuclear Energy Conference

At a recent meeting of the BNEC over 20 papers were presented on the subject of steels in reactor pressure circuits. These papers covered factors governing the selection of steels, fabrication aspects, irradiation, high tensile properties, corrosion, and steels for future reactors. Sir Leonard Owen of the UKAEA gave an introductory lecture entitled "Steel and nuclear power" in which he examined the difficulties involved in the construction of nuclear reactors due to the quality of the materials available to the engineer and the need for new techniques. Many of the difficulties experienced in the construction of Calder Hall have now been overcome or at least alleviated, however, in his concluding paragraph Sir Leonard claimed that the "full benefits of nuclear power cannot be realized so long as the engineer is limited by the materials available to him. If suitable steels are not available he may have to explore alternative materials. The reactor designer feels he is entitled to look to the steel industry for a lead in the problem." The synopsis from a number of the papers which were then presented are reproduced below. A full version of the papers will be published later this year by the Iron and Steel Institute.

Practical neutron dosimetry for steel irradiation studies *by L. E. Steele.*

THE HIGH NEUTRON and gamma flux levels typical of reactor facilities, commonly used for the irradiation of steels, effectively limit neutron dosimetry techniques to threshold activation detectors. Practical neutron monitors must be selected by the research worker on the basis of their physical and nuclear characteristics and the limits imposed by the objectives of each experiment to be monitored. The value of preliminary neutron flux surveys, and the problems of measuring and interpreting neutron flux values, vary from one reactor to another as demonstrated from practical experience in various U.S. Atomic Energy Commission research reactors.

Correlation of neutron flux data with shifts in the ductile-brittle transition temperature for various pressure vessel steels demonstrates how property changes may be useful in assessing the validity of neutron dosage values.

Progress in development of some improved steels for gas-cooled reactor pressure vessels *by I. M. Mackenzie, BSc, AIM.*

THE PROPERTIES required in steels to be used for the pressure shells of gas-cooled nuclear reactors are briefly summarized, and reference is made to the laboratory tests employed to assess these properties. An account is given of progress in a research programme with the object of developing three improved steels as follows: (*a*) a 28-32 ton/sq.in tensile low-carbon high-manganese steel treated with aluminium and molybdenum to combine good notch ductility and high temperature strength; (*b*) a multiple-alloy high-tensile steel based on a proprietary boiler steel extensively used for pressure vessel construction; (*c*) a quenched and tempered low-carbon multiple-alloy steel providing high strength and toughness combined with gocd weldability.

Mention is made of problems such as the effect of stress-relieving treatments on the properties of the steel. Finally, existing steels are compared with those under development, the basis for comparison being conservative minimum values which could be guaranteed for various important properties.

Steels for nuclear power plant *by K. J. Irvine, BSc, PhD, and J. D. Murray, AMet, AIM.*

SINCE future developments in nuclear power plant seemed likely to involve increased operating temperatures it was considered that there was a need for a creep resisting steel for the reactor pressure vessel which would have considerable weldability and impact resistance. From the starting point of an aluminium-killed fine-grain steel which has good impact resistance but poor impact strength, an attempt was made to increase the creep strength both by a Mo-V addition and also by using an increased nitrogen content. The creep strength was increased by both methods but the Mo-V steel was preferred because of greater stability during extended tempering treatments. The steel selected was Affreeze III (0.12 per cent. C, 1.3 per cent. Mn, 0.22 per cent. Mo, 0.07 per cent. V), and from a programme of creep tests it was found that with a design stress of 7 ton/sq.in. and using a criterion of 0.1 per cent. creep strain in 100,000h, this steel would have a maximum service temperature of 420°C.

For an operating temperature above this, it is necessary to use one of the standard creep-resisting steels such as Esshete CML (1 per cent. Cr, ½ per cent. Mo). With reasonable control of rolling conditions, satisfactory impact properties can be obtained, and with a controlled aluminium addition of 1 lb/ton the expected good creep properties are obtained. For heat exchangers it is suggested that stress-to-rupture is the correct method of assessment and on this basis Esshete CML has an appreciable strength advantage compared with mild steel up to 500°C.

A number of steels have been assessed on the basis of their 0.2 per cent PS at elevated temperatures. It has been shown that bainitic steels of the Fortiweld type have appreciably higher strengths than steels with ferrite/pearlite structures at temperatures up to 400°C.

ULTRASONIC CLEANING PLANT

Valves and fittings for a nuclear installation being loaded into the autoclave in the vacuum cleaning plant

TO meet the standards of cleanliness now demanded by the UKAEA and manufacturers of nuclear plant, Cockburns, Ltd., of Glasgow have built a £20,000 ultrasonic cleaning plant. This is the first such plant to be built in Scotland and means that the expensive and lengthy cleansing methods used to date can be dispensed with.

The clean conditioning room installed consists of an airtight structure of insulated steel panels with an air-lock door. Clean, dust-free air filtered to 5 microns is supplied by an air-conditioning plant which maintains an internal pressure of 2 in. w.g. above atmosphere so that dust cannot enter. Due to atmospheric conditions, a special fog filter has been installed. Operating personnel wear special nylon clothing and there is a changing room with showers.

The cleaning plant consists of a specially designed 2 cu.ft autoclave with revolving carrier, solvent sprays and transducers in the base for the introduction of ultrasonic waves. The autoclave is inside the clean conditioning room and is connected to a closed circuit solvent supply and drying system. The system is controlled by pneumatic valves, embodies storage tanks for preheating and conditioning of the perchlorethylene solvent, a filter battery pump and ring vacuum pump. A distillation plant has been installed outside the clean room; it consists of a still and a condensing unit.

Solvent cleaning and recovery plant and clean conditioning room. The air conditioning unit is on the other side of the clean room

An operator about to enter the air lock of the plant

The sequence of operation is prerinsing, solvent cleaning with ultrasonic waves and vacuum to remove air from all cavities, and vacuum drying, all carried out in the same autoclave at a predetermined temperature. Preconditioned solvent is fed into the autoclave through sprays, while the carrier rotates, exposing all surfaces of the component to the solvent spray. The complete removal of all solids is ensured by recirculating the solvent through the filter battery.

The autoclave is refilled with filtered solvent, vacuum is applied to 70 cm Hg, and held while the generators are switched on, thus introducing ultrasonic waves through the transducers. The carrier is rotated to ensure complete cleansing.

The load next receives a final rinse, solvent is drawn off, and vacuum is applied to the autoclave for drying. A cooling coil situated in a sump at the back of the unit condenses the vapour into the coil chamber, leaving the work perfectly dry, and cleaned down to 1.5 micron filter.

The load is then removed and components are assembled and sealed in polythene containers, and stored in the clean conditioning room until required for despatch.

Book Reviews

Modern Nuclear Technology—A Survey for Industry and Business. Edited by Mark M. Mills, Arthur T. Biehl and Robert Mainhardt. Published by McGraw-Hill Book Co. Size 9¼ in. × 6½ in. Price 74*s*.

The editors of this book state that it is mainly the lectures given by some 20 speakers to a one-week course on " Nuclear Engineering for Management " at the University of California in 1956 and in 1957. There is a risk of duplication among such lectures, but the editors state that they have made little effort to cross-correlate between them. Each speaker clearly used his special knowledge to contribute a well-considered lecture, which forms a chapter of the book, fitting in with the general plan of the course. It seems a pity that such efforts should only reach the immediate hearers, and this book is a means of wider distribution. However, it is necessary to consider what section of the public will find it valuable. A course or book for management normally assumes that the readers do not necessarily have high scientific qualifications. They will presumably not be called upon to take technical decisions regarding the design and safety of nuclear plant. For people wishing to take those decisions, there are technical courses and books which are drier, but more economical of effort in the long run, since they start from general theories and work outwards to applications. For the manager of an organization handling major nuclear technical decisions, the present book would provide little more than the vocabulary, etc., to enable him to listen intelligently to the decisions being taken. That may be the function of management at some levels: not so much to take decisions as to ensure that decisions are being conscientiously taken by sound men. However, there are few men in that position, and no doubt they will in fact have mastered more of their subject than is contained in a one-week course. There may be more managers of firms supplying components or services to the nuclear industry, or wondering whether they could do so. For them, a brief general background of information about the industry would be useful or interesting. The course was presumably intended to provide that. The first few chapters amount to a very compressed theoretical introduction. There are inevitably many simplifications. There are also some quantities left undefined but referred to later. A glossary of terms helps to fill these gaps, though the compression is evident in the attempt, for instance, to deal with temperature coefficient of reactivity mainly by an entry in the glossary. Other chapters deal with fuel cycles, material processing, economics and outline descriptions of certain American reactors, mainly as they stood in 1957 or 1958. One can hardly expect that detailed information in a book would be completely up to date. It is for the technical press to provide more recent information and occasional surveys of the field. Other chapters describe the organization and administration of the American nuclear industry. This is of rather less value to the British reader, though it is interesting to note the greater use of non-Governmental organizations. Consequently private consultative organizations were soon available to specify and design research reactors on a commercial basis, despite the absence of a major power reactor programme. Later chapters deal briefly with safety and medical aspects. Final chapters consider future applications, including a summary of the 1957-1958 position of thermonuclear research. The book contains some references to work outside America, including the economics of Calder type of plant, but it is mainly a survey of the American nuclear industry in about 1958. It is too brief for the specialist but, as its sub-title implies, it may be of value to the interested non-specialist.

M.G.C.

Fundamentals of Digital Instrumentation, by D. S. Evans. Published by Hilger and Watts, London. 39 pp. Price 7*s*. 6*d*.

The author has aimed at producing " a monograph to help fill the gap between the rather scattered magazine articles and sales leaflets, and the practically non-existent technical books." In steering this middle course, it was presumably clear in the mind of the author to what readership his work was to be directed. It is not so clear to the reader. For the beginner, hoping to know just what digital instrumentation means, a more elementary treatment would be better, at least in the beginning. To those who already know the principles, but want to know the range of applications of these techniques, a more extensive volume would probably have greater appeal. What appears in this book is, however, quite sound, very lucid, and well-illustrated by diagrams and photographs. The author has written on coding digitizers, decoding, cycling, sampling and storing, time sharing, and types of digitizers and their uses. His examples provide an insight into the art of data processing, but they touch only on the fringe of the subject, as the author points out. This little volume, nevertheless, will have the salubrious effect of whetting the appetite, to inspire its readers to seek more information on this important and fascinating subject. The price of this book seems very high when one considers its very modest size.

F.R.P.

Un Annuaire de l'atome.

Tous ceux qui s'intéressent de près ou de loin à l'atome seront heureux d'apprendre la parution d'un " Dictionnaire-Agenda-Annuaire-atomique 1961." Il s'agit d'un volume 170 × 240 mm de 320 pages, comprenant notamment: un agenda étendu, des calendriers, un éditorial illustré sur " l'année nucléaire 1960," une liste à jour des fournisseurs du domaine atomique; un dictionnaire nucléaire très complet de 100 pages, des tables de constantes nucléaires, les caractéristiques des centrales atomiques existantes ou projetées, table analytique des matières, etc.

Cet ouvrage, que nous recommandons, provient du même éditeur que la revue internationale: Industries Atomiques: Editions René Kister, 33, quai Wilson, Genève, ou l'on fera bien de le retenir, le tirage étant limité. Prix: fr.s. 15.--. Pour la France (NF. 17.--): Editions de la Grange-Batelière, 10, rue Chauchat, Paris 9e.

Kernenergie Technik, by H. Engel and K. O. Thielheim. Published by Verlag Moderne Industrie, Munich 23. 300 pp. Price 36DM.

As Professor Bagge points out in the foreword, many books on nuclear energy have appeared since the Federal Republic has been allowed to concern itself with atomic affairs once more. Most of the books, however, have been either highly technical treatises directed to a readership of the specialist type, or popular works to assuage the intellectual thirst of a public long mentally starved by a political system which did not encourage free thinking. The authors steer a middle course in this book so that engineers or the more informed laymen can acquire a sound knowledge of the role played by the physics and technology of nuclear reactors in industrial and economic developments. In this they have succeeded remarkably well. As one might expect, the book starts off with some fundamental nuclear physics, and then it deals with chain reactions, reactor control, cooling and shielding, the technology of fuel elements, and the question of radiations. In the second part of the book we find descriptions of the various principal reactor types with examples drawn principally from British, American and Canadian experience. The third section is devoted to economic considerations, with special reference to the U.K., U.S.A. and U.S.S.R. There are chapters on the peculiar problems of the European countries, developments in the German Federal Republic, and marine propulsion. Finally, a section dealing with future developments includes the possibilities of nuclear fusion as a power source. There is an adequate bibliography. Throughout the book, the authors have carefully refrained from becoming too highly technical, yet in no way is their treatment superficial. They have produced a very readable, authoritative and convincing story which should be much appreciated by its readers. There are 100 figures, including several photographs, and 60 tables, and all of these are appropriate to the text and well-produced. The text should provide a solid groundwork for those likely to specialize later in nuclear power technology, and the authors are to be congratulated on presenting a book which certainly fills a gap in the literature available to the German-speaking people.

F. R. PAULSEN

RECIPROCAL benefit between various fields of human knowledge is an objective all too difficult to realize, but one towards which all should strive. The science of semi-conductors has gained a great deal from the applications of nuclear energy and now I notice that semi-conductors have been able to help those who work in the nuclear field. UNESCO will be organizing in Paris this April an international colloquium concerned with devices based upon semi-conductors. One of the items which will certainly attract a good deal of attention, especially among medical men, will be a device for measuring radiation doses received by people. Based upon the utilization of small photographic films, which can be placed at definite sites on or in the human body, this device has been developed at the "Traian Vuia" Institute of Applied Mechanics at the Academy of the Rumanian People's Republic. The films, after exposure to radiations, are developed, and then inserted in a densitometer which operates on semi-conductor principles, and the radiation dose may be read off. There is, of course, little that is fundamentally new about all this. Photographic films and the effects of radiations on them, the use of densitometers, and so on, have all long been known. However, this technique, invented by an engineer, Dan Pavelescu, is simple in design and construction, and very cheap, so that it can be mass-produced and used on a large scale for the protection of personnel working in the fields of atomic energy. This device shows, when considered with other evidence that Rumanian scientists are paying more attention to the practical aspects. Rumanian research has long been almost exclusively in the theoretical field. However, at the colloquium on Applied Physics, organized by the RPR Academy and the RPR Society of Mathematics and Physics, which took place in November last, in Bucharest, this new and welcome trend was reflected in the 18 papers and 58 reports. Many of these were presented not by professors of science faculties, but by technologists.

* * *

Another development concerning the health and safety of atomic workers has been announced in Germany. From the nuclear research centre, or Kernforschungszentrum, at Karlsruhe, comes the news of the development of a chemo-therapeutical method for radiation protection. Professor Alexander Catsch has produced a chemical which eliminates radioelements from the body. This substance known as DTPA, is made by Geigy, in Switzerland, and has been tested in the U.S.A. on actual radiation casualties. The substance is the calcium trisodium salt of diethylene triamine-penta-acetic acid, and it can be used either in the form of intravenous injections in solution, or, with somewhat diminished efficacy, in the form of tablets taken orally. Its curative action is not so powerful as its preventive action, but it can speed up 100-fold the elimination of plutonium from the body. Unfortunately, this chemical has so far failed to speed the elimination of radio-caesium and radio-strontium.

'NUCLEARIST' writes . . .

This need not be taken as a serious drawback at the moment, since the success so far achieved with DTPA will most certainly spur Professor Catsch and his team to further research on related compounds, to see if they can find a modification of the formula giving better results with other ingested elements. This is very remarkable work, and deserves success and every possible encouragement.

* * *

Having spoken of hope for radiation casualties, it is not difficut to refer to atomic weapons. I suppose the story of the A-bomb will always be read with mixed feelings. There must be horror (I hope) at the tragic developments which came from a perfectly genuine scientific discovery, and also admiration for the skill, ingenuity and patience of those who, starting from experiments in small laboratories, brought into being a vast colossus of engineering accomplishment, and large-scale chemical processes based upon reactions carried out with invisible amounts of material, with hardly any opportunity for the usual pilot-scale trials. Ronald Clark writes "The Birth of the A-bomb" in the *Sunday Times*. His story begins in December, 1938, when a young Viennese scientist crossed from Denmark to Sweden to spend Christmas with an aunt who had escaped from Germany and who had just received a letter about an experiment. A homely enough beginning for a ghastly future, of which the mighty blast over Hiroshima was but one small token of the possibilities. Ronald Clark's feature will be read, and I hope pondered carefully, by millions of people.

* * *

For over two years the Sodium Reactor Experiment, operated by Atomics International, has been producing heat which the adjacent plant of the Southern Californian Edison Company has converted into 15,300 MWh of electricity. This represents an overall power output of only 1 MW, and this is insignificant by comparison with the giant nuclear power stations in Britain. However, it must be remembered that this is only an experiment, and it has played an important role in the development of the Hallam Nuclear Power Facility which is being constructed at the Consumers Public Power District of Nebraska, and which will generate 75 MW. Now the SRE has been refitted with a second operational core, consisting of uranium-thorium alloy elements, of which 31 were required for criticality. After some months of critical work and low power physics tests, the reactor will be brought to full power on its new loading, and will be used for the testing of the new fuel elements as part of the USAEC's power programme for sodium graphite reactors. It does not look as if the faith placed in it is to be easily shaken. Dr. Chauncey Starr and R. W. Dickinson put forward some very convincing data for this type of reactor in their book "Sodium Graphite Reactors," and it certainly looks as if this concept has quite a bright future.

Westminster talks about...

by Peter Lewis—Our Parliamentary Correspondent

MR. **William Yates** (C., The Wrekin) gave the impression that his appetite for Christmas delicacies would be considerably impaired if the House were not given more information about the possible manufacture of atomic weapons in Israel. **Mr. S. Silverman** (L., Nelson & Colne), said he could have sympathized with Mr. Yates much more if he had included the new contribution of nuclear weapons to Europe. Coincidental with this debate was the publication of a second report to the Medical Research Council on the hazards to man of nuclear and allied radiations. Although this correspondent took the report home it was not holiday reading, and anyway will take some absorbing, after which I hope to make some comments on the report. After a brief look, it would be easy, but dangerous, to become an alarmist and imprudent to comment on first impressions.

Power Stations

In reply to a question from **Mr. G. H. Oliver** (L., Ilkeston) about the choice of nuclear as opposed to conventional power stations, **Mr. George,** Parliamentary Secretary to the Ministry of Power referred to the White Paper "The Nuclear Power Programme" published last June, and pointed out that in the long run we should need increasing supplies of nuclear power. In about ten years time it should be cheaper to generate base load in nuclear rather than conventional stations provided that expected technological progress is achieved. Mr. George ended by saying that, to secure this the Government must continue to build nuclear stations on an adequate scale.

The problem of radioactive waste, and in particular that arising from servicing nuclear submarines at Holy Loch prompted **Mr. Dickson Mabon,** (La/Co., Greenock) to ask the Prime Minister when it was proposed to set up a National Radioactive Waste Disposal Service under the Radioactive Substances Act 1960. In a written reply the Prime Minister, **Mr. Harold Macmillan,** said that naturally he took a close interest but the Ministers most immediately concerned were the First Lord of the Admiralty and the Secretary of State for Scotland. Mr. Macmillan also said he had been informed that a National Radioactive Waste Disposal Service would probably be established within a year.

Nuclear Submarines

Later in the month **Mr. R. Paget** (L., Northampton) asked the Civil Lord of the Admiralty what was the extent of radioactive discharge from Polaris and the engines of nuclear submarines and what form the discharge was expected to take. The Civil Lord, **Mr. C. Ian Orr-Ewing** pointed out that there was no radioactive discharge from the Polaris missile (it is sincerely to be hoped not), but went on to say that, the discharge from the nuclear reactor of a submarine was a liquid effluent. It took the form of excess primary coolant and arose when the reactor plant was brought up to operating temperature after being shut down. The effluent was discharged into the water, but the level of radioactivity was low and the amount small. The discharge took place only infrequently, such as when a submarine was getting ready for sea, and within agreed limits was designed to ensure that no hazard was created.

British Nuclear Ship

Major P. H. Wall (C., Haltemprice) took up the cudgels once more on behalf of those avidly awaiting the construction of a British nuclear-powered merchant ship. He asked the Minister of Transport when he would announce the award of a tender for such an undertaking. **Mr. Marples** replied that he regretted that he was not in a position to forecast when a decision would be reached. Major Wall then asked when Mr. Marples would be in such a position and was the Minister aware that there was a suspicion that the AEA, and its advisers were "dragging their feet in this matter." Major Wall thought that any delay would have grave repercussions on Britain's future as a shipbuilding nation and even as a maritime Power. Mr. Marples retorted that it was a very complicated matter. Not only was the AEA on the technical committee concerned, but also shipbuilders, ship owners and Lloyd's Register. "None of them has complained that the Atomic Energy Authority is dragging its feet" and Mr. Marples assured Major Wall that this indeed was not so.

Sr-90

Mr. R. Sorensen (L., Leyton) asked the Minister of Health, representing the Minister for Science, to what extent an increase in the presence of strontium and leukaemia had been detected in infants, children, young people and adults, respectively, during the past two years. Replying, **Mr. Enoch Powell,** The Minister of Health said that the average levels of strontium-90 measured in bone during 1959 as a whole, showed some increase on those recorded during 1958 for still-born infants, children and young people, but there had been relatively little change from the first to the second half of 1959. As the answer to the second question regarding leukaemia contained a number of figures, Mr. Powell said that he would circulate it in the Official Report.

NUCLEAR NOTES

X-ray machine

THE world's most powerful X-ray machine specifically designed for high-speed radiography in the metals industry, will be installed at the A. O. Smith Corporation's Milwaukee, Wis., plant next spring. The 8 MeV linear accelerator is at present being built by the High Voltage Engineering Corporation. The linear accelerator, or "Linac," is designed to "see" through steel more than 1 ft thick and to provide photographic proof of the soundness of such metal structures as core barrels for nuclear reactors and high pressure vessels for the petrochemical industry. The Linac produces its X-rays by "firing" high-energy electrons in a straight line down an evacuated tube. The electrons from the Linac move down the tube, impelled by travelling radio-frequency waves. These "radar" pulses accelerate the electrons until they approach the speed of light, or 186,000 miles/sec. At the end of the tube, the electrons strike a tungsten target and produce penetrating X-rays which are beamed upon the material to be examined. The operating head or tube of the new Linac will be 11 ft long and 30 in. in diameter, with a 12 in. radiation aperture. Using 8 MeV, the Linac will produce 6,000 roentgens/min. Higher voltages are used in some other types of equipment but they do not produce X-rays of such high intensity. The new Linac will be equipped with an X-ray source providing a choice of focal spot sizes of 1 mm and 5 mm. The respective outputs are 1,500 and 6,000 roentgens/min, making possible the radiographic examination of very thick metals with both speed and clarity. The Linac will be housed in a special building, now under construction, with 6 ft thick concrete walls. The new building also will contain special laboratories for processing and interpreting the films. The room housing the operating head of the Linac will be 40 ft × 80 ft in size, and it will be possible to bring into the room railroad flat cars carrying the material to be radiographed. In operation, the Linac operating head will be suspended from an overhead crane to permit raising it from floor level to a height of 16 ft. It can be tilted to point its beam vertically downward or it can be rotated to 45° upward. However, its arc is limited so that it can never be aimed at the main entrances to the room. In addition, special interlocks prevent the operation of the equipment if any of the lead-shielded doors are left open. With the exception of the control console, which is located in the laboratory section of the building, the Linac will be completely self-contained on its mounting, including its own cooling system. To ensure the greatest possible reliability, the main power tubes will need to operate at only one-third of their rated capacity to produce the maximum requirement of roentgens.

Pressure vessel examination

THE first completely mobile linear accelerator in the world has been delivered to the UKAEA. The 4.3 MV accelerator has been designed to make X-ray examinations of pressure vessels in nuclear power stations during construction. Welds in the 4 in. thick steel spheres of the pressure vessels containing the reactor cores can now be radiographed on site with a minimum of disturbance to construction work. This machine will be used for the first time in the construction of the nuclear power station at Trawsfynydd. The accelerator, which was designed by Mullard Research Laboratories, is a compact self-contained unit weighing two tons.

Tokai-mura reactor

THE Japan Atomic Research Institute has now officially taken over the largest nuclear research reactor in the Far East which is situated at Tokai-mura, some 70 miles from Tokyo. The reactor was built for the Institute by the American Machine and Foundry Company at a cost of $1,500,000. The reactor is a 10 MW JRR-2 heavy water, tank type of all-aluminium construction. Although it uses heavy water as a moderator the reactor is designed with a light water and steel thermal shield instead of the usual graphite and lead shield. This will, it is hoped, reduce the possibility of radiation damage in the reactor. Water can be drained from and put into the tank with the maximum convenience. The reactor is fuelled with 3 ft long fuel elements which makes for easier handling and reduces the size of cask required for refuelling. The reactor is to be used for fundamental research, materials testing and isotope production.

U.S.S. Enterprise

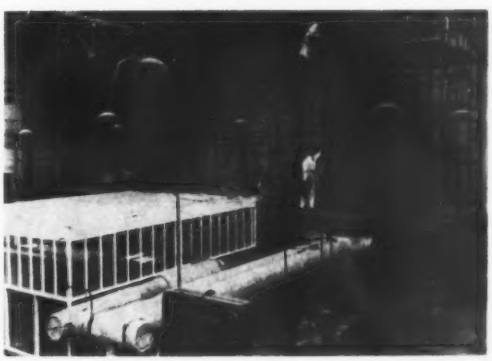
CRITICALITY has been achieved in the first of the eight reactors on board the American nuclear aircraft-carrier *U.S.S. Enterprise* which is under construction in Virginia. This is the first sustained nuclear reaction on board an American surface ship and was preceded by months of intensive testing of the plant. The reactors have been developed by Westinghouse Electric Corporation at the Bettis atomic power laboratory. The *Enterprise* was launched in September, 1960, and is due to begin sea trials towards the end of 1961.

A.M.F.-Pye agreement

AS the result of a licensing agreement between the American Machinery and Foundry Company of the U.S.A. and Pye, Ltd., of Cambridge, AMF reactors are to be manufactured and sold in the United Kingdom. This arrangement is an extension of the earlier agreement between those two companies on master-slave manipulators which was signed in 1956. Under the terms of the new contract Pye will offer U.K. universities, hospitals and research centres the AMF series of low-power reactors and ancillary equipment. Nuclear co-operation between the two companies is also anticipated throughout the British Commonwealth, Iraq, Jordan, and Egypt.

Fairey work on Hector

Fairey Engineering, Ltd., have recently released information on the work they have done for the UKAEA on research reactors. This illustration shows a temperature stability test rig during erection at Fairey's Heston works. A graphite stack contained within the vessel surrounded by scaffolding is being used to simulate the core of HECTOR to develop methods of achieving the very accurate control of temperature required



NUCLEAR NOTES

Euratom contracts

INFORMATION regarding all Euratom research contracts is in future to be published in the *Journal Officiel des Communautes Europeennes*. To date Euratom has concluded 47 contracts, seven for the ORGEL project, six contracts of association, seven relating to studies carried out by the Scientific Data Processing Research Team (GRISA), two on behalf of the Central Nuclear Measurements Bureau and one for the Ispra research establishment.

Waste disposal

AN international panel of experts has been convened by the IAEA to consider radioactive waste disposal into fresh waters. The panel is due to meet again in a few months' time; its work is complementary to that completed last year on waste disposal into the sea. Some diluted wastes are released directly into fresh waters or reach them indirectly, for example by being washed out of the soil into ground water. All released radioactive wastes are potential radiation sources to man and there is a possibility that waste materials in fresh waters may pollute drinking water or foodstuffs. International problems arise since many rivers flow through more than one country, and lakes, glaciers and other fresh water bodies may also be shared by several countries, ground water may move across international frontiers.

New York power station

A THREE-YEAR development programme is to be carried out by General Dynamics Corporation with the aim in view of constructing a nuclear power station of at least 300,000 kW capacity in New York State. The work has been commissioned by seven investor-owned electric utility companies to determine whether a plant of 300,000-500,000 kW capacity based on the high-temperature, gas-cooled reactor system can produce electricity using modern steam conditions and at a cost in the range of that for power generated in fossil-fuelled plants in New York State.

I.A.E.A. and E.N.E.A. protocol

THE protocol regarding the collaboration agreement between IAEA and ENEA was signed recently in Paris. The signatories were Mr. Sterling Cole (IAEA) and Mr. Pierre Huet (ENEA). The two organizations have already been collaborating fully in a number of fields and it is hoped that this collaboration will now be extended to all fields. Mr. Sterling Cole attended the meeting of the ENEA Steering Committee which followed the signing ceremony. At this meeting methods were considered for increasing co-operation between European countries in the fields of advanced research and nuclear ship propulsion.

Nuclear power costing

IAEA's panel of experts on nuclear power costing have held a second meeting in Vienna. Detailed consideration was given to the manual on this subject which IAEA hopes to issue in the first part of this year. The complexity and wide variations involved in nuclear power costing in the more advanced countries has created considerable difficulties for the less developed countries in applying the available costing figures to themselves. It is hoped that the proposed manual will serve as a guide to these countries.

Outside view of a training and research reactor of the type which is to be manufactured and sold by Pye of Cambridge

D.I.D.O. modified

MODIFICATIONS have been carried out to the core of DIDO which have increased its operating power from 10 MW to 13; the maximum thermal neutron flux remains the same at about 2×10^{14} neutrons/sq.cm/sec. This is because the power of a thermal reactor depends on the product of the mass of uranium-235 in the core and the magnitude of the thermal neutron flux. The procedure involved in this operation is the same as that used for the start-up of a completely new reactor. As expected, all the reactor physical characteristics had to be measured during the period of low-power running. The new DIDO core consists of 25 hollow fuel elements with an increased U-235 content. The old plate type fuel elements contained 115 gm of U-235 per element whereas the new type contains 150 gm of U-235 per element. Experimental rigs of up to 2 in. diameter can now be accommodated within the fuel elements in regions of extremely high fast-neutron flux. The modifications have increased the total number of available high flux experimental positions from 27 to 52; the additional positions within the fuel elements will be of great value for high dose irradiation damage studies of graphite, fuel canning materials and other materials for power producing reactors. The UKAEA have three high flux reactors, DIDO and PLUTO at Harwell and DMTR at Dounreay. A similar modification will be carried out to the core of PLUTO during 1961.

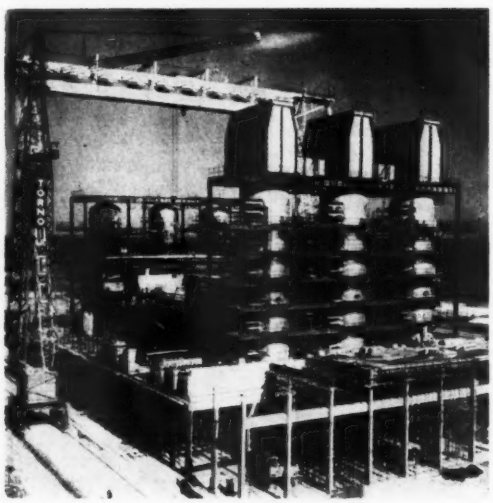
Nuclear rocket

JOHN W. SIMPSON, vice-president, atomic power division of Westinghoues Electric Corporation, has claimed that the U.S.A. could launch a 35-ton payload into space within the next seven years by using nuclear rockets. Provided the development programme was organized, he said that electrical power systems of over 1,000 kW could be carried in the 35-ton payload.

Iran reactor

MR. WILLIAM C. BURCH of the IAEA has arrived in Iran to assist the Government in the construction of a nuclear research reactor and associated laboratories at the

Latina heat exchangers



The six heat exchangers in position at Latina nuclear power station in Italy. These vessels were designed by Head Wrightson and built in Italy by Nuovo Pignone. The power station is being built by The Nuclear Power Group

NUCLEAR NOTES

Nuclear Centre of the University of Teheran. Mr. Burch is the first IAEA expert to be sent out in connection with a reactor construction project. This reactor will have a capacity of 5 MW and be of the swimming pool type; it will be manufactured by the American Machine and Foundry Company. The U.S.A. will pay $350,000 towards the cost under a bilateral agreement with Iran. Mr. Burch has been sent under the U.N. expanded programme of technical assistance.

Dungeness blowers

AEI have started work on eight large carbon-dioxide blowers for the Dungeness nuclear power station being built by the Nuclear Power Group. These machines, which will have casings of about 15 ft diameter, will each pump well over a ton of carbon-dioxide gas/sec, at nearly 300 lb/sq.in. gauge, through 6 ft 6 in. diameter pipes to the reactor and associated heat exchanger. The blowers will be driven by 10,000 h.p. back-pressure steam turbines, to be manufactured at the AEI's Larne factory. An order has also been received by AEI for the supply of reactor rod controls and associated automatic control gear.

S. African atom smasher

POTCHEFSTROOM University, South Africa, is buying a 2 MV atom smasher from Cambridge—a £40,000 Cockcroft-Walton accelerator. Dr. M. A. Meyer, senior physics lecturer at Potchefstroom, at present in England on a Nuffield scholarship, has said the accelerator would be used chiefly for fundamental research, in collaboration with the South African Atomic Energy Board; but the board may possibly wish applied research to be carried out with the machine. Dr. Meyer is working at the Cavendish Laboratory, Cambridge. He will help in dismantling the accelerator as he will be in charge of its re-erection at Potchefstroom. The accelerator is expected to reach South Africa early next year. This is the second machine Cambridge has sold to a South African university this year. The first—a 1 MV one-column accelerator—went to the University of the Witwatersrand.

Canadian Association

CANADA's first conference on nuclear energy, sponsored by the Ontario Government early in 1960, revealed the need for an organization in Canada to encourage and promote the peaceful use of atomic energy. It is as a direct result of this that the Canadian Nuclear Association has been formed. The Association is intended to provide a forum for discussion, sponsor conferences on nuclear energy, and to aid co-operation between the various bodies interested in the nuclear industry. The offices of the Association were opened on January 1st, 1961.

Nuclear ship tenders

KERNENERGIEVERWERTUNG im Schiffbau und Schiffahrt GmbH in Hamburg have announced that they are accepting tenders for a 20,000-ton nuclear-propulsion ship with a 10,000 h.p. engine. The ship is to be 170 m long and 24 m wide, but competitors are allowed to submit a type they prefer (tanker, cargo or passenger ship). The nuclear part must be easily replaceable because it is planned to experiment with various types of reactors. The ship is to be ready in 1964 and its cost has been fixed at $16,500,000. It is pretty certain that Euratom will contribute from $3,500,000 to $5,000,000, while the rest will be provided by the Federal German Government, City of Hamburg and other *Laender* participating in the scheme. The cost of the ship will be subdivided in the following manner: building, $8,300,000; operation during first year, $2,100,000; overhead of the builder-company during five years, $3,600,000; research in co-operation with other Euratom countries, $2,300,000.

Italian power stations

THE two Italian nuclear power stations (one at the mouth of the Garigliano River and the other near Latina) are at an advanced stage of construction. Their aggregate cost will be about 100 mld lire. The former is being built by Societa' Elettronucleare Nazionale (SENN), which belongs to the IRI Group, and the latter by the Societa' Italiana Meridionale Energia Atomica (SIMEA), a member of the ENI Group, in which IRI has a 25 per cent. holding. The Latina station will go into operation in the middle of 1962 and the Garigliano plant in 1963. The former is scheduled to produce about 1,200m. kWh a year and the latter about 1,000m. kWh a year.

Finnish reactor

THE IAEA has recently undertaken to help Finland to obtain a 100 kW research and training reactor from United States sources. The reactor will be a TRIGA Mark II supplied by General Dynamics Corporation. The IAEA has also undertaken to arrange the transport of the fuel to Finland. The fuel will consist of about 13,000 gm of uranium enriched to approximately 20 per cent. by weight in the isotope U-235 and approximately 5 gm of uranium enriched to more than 90 per cent. Total cost of the fuel will be about $42,000.

Co-operation agreement

THE co-operation agreement between the IAEA and the Inter-American Nuclear Energy Commission has now been formally signed. The purpose of the agreement is to facilitate co-operation between the two organizations and to encourage regular consultations on matters of common interest. Information and documents will be exchanged, and arrangements made for co-operative use of personnel, materials, services, equipment, and facilities.

Translation pool

A JOINT translation pool has been set up by the UKAEA, the USAEC and Euratom. These organizations are to co-ordinate their efforts to collect and disseminate information on nuclear literature translations, especially from such languages as Russian and Japanese. With this objective, a central information office, " Transatom," has been established in Brussels at Euratom headquarters. A monthly *Transatom Bulletin* will be published in which existing and intended translations will be listed. These lists will include translations commissioned by international and national institutions and private firms. All data relating to translations is to be collected in

X-ray unit at Hunterston

Using a Pantak 400 kVp mobile X-ray unit to examine welded pressure vessels at Hunterston

NUCLEAR NOTES

a master filing system and copies of this will be available to those interested from Transatom, 51, Rue Belliard, Brussels, Belgium, at $8 per annum.

I.A.E.A. annual report

IN presenting his report to the U.N., IAEA's director-general claimed that present estimates of nuclear power are generally more optimistic than they were two years ago. Despite this the production of cheap electricity motive power and heat from nuclear fuels " still remains to most countries a prospect for the future rather than a reality for the present." According to this report the " cost of nuclear power is falling quite fast, faster than that of conventional power, but from a greater height "; however, it is unlikely that the two curves will intersect before the latter part of the 1960s. On the other hand, Mr. Cole said that the use of isotopes and radiation continues to flourish and expand and the Agency is beginning to see the first results from its work in spreading this technology in the less developed areas. Mr. Cole gave the following facts and figures: 420 fellowships were granted in the last year, aid was given to 27 countries, 31 scientific reports were issued, *Nuclear Fusion* was published for the first time and nine scientific meetings were held, attended by 2,000 scientists from 40 countries.

C.E.R.N. organization

THE internal organization of CERN has been modified so that it now consists of 12 divisions instead of six. The 12 divisions will be concerned with the following: the proton synchrotron machine, the synchro-cyclotron machine, nuclear physics experimentation, engineering, data handling, theory, track chambers, nuclear physics apparatus, accelerator research, site and buildings, finance, and general administration. In addition to this a directorate is to be formed to assist the director-general. The directorate will consist of two research members, one administration member, and one member for applied physics.

New U.K.A.E.A. products

THE UKAEA Radiochemical Centre at Amersham has issued two new supplements, one to the catalogue of " Radioactive Chemicals " and the other to the catalogue of " Radioactive Sources." Eighteen new organic compounds labelled with carbon-14 are listed; these range from insecticides to steroids and many of them are in high specific activities. Also included are 26 sulphur-35 compounds, 13 phosphorus-32 and 27 labelled with tritium. A number of new sources are also available. These include neutron sources of new types and improved methods of construction. Promethium secondary X-ray sources and Krypton-85 beta radiation sources are listed in the supplements which also draw attention to the availability of two ranges of material for calibrating radioactive measuring equipment. The first of these comprises absolutely standardized solutions, the certified activity and radioisotopic purity of which are measured to a high degree of accuracy. The second range covers reference solutions which are certified, but are less accurately calibrated. The supplements have been issued largely due to the intensified demand for radioactive materials.

Finnish prospects

THE report has recently been issued of a joint study by the Finnish Atomic Energy Commission and the IAEA on nuclear power prospects in Finland. From this report it seems clear that to date the situation in Finland has not been favourable to the introduction of nuclear power due to the abundance of hydro-electric power. However, it seems that the hydro-electric potential is now much smaller and conditions are much more favourable for the introduction of nuclear power. The report suggests that further studies of the situation should be made.

Canada India reactor

SIR ROGER MAKINS, chairman of the UKAEA, represented the U.K. at the recent formal opening of the Canada India Reactor at Trombay. Both Sir Roger and Sir John Cockcroft presented papers on aspects of the U.K. nuclear power programme at a symposium held after the opening.

Latvian research centre

PLANS have been announced for the establishment of a nuclear research centre in Latvia. The research reactor at present under construction near Riga is to be part of this centre. Linear and proton accelerators are to be built, and provisions are included for studying radiations and radioactive substances and their applications.

C.E.G.B. investigations

INVESTIGATIONS by the CEGB into the suitability of sites at Earnley, Sussex, and Hamstead, Isle of Wight, for nuclear power stations have now been completed. The conclusions reached are that Earnley is technically unsuitable but that Hamstead provides an excellent site. Despite this, the Board has decided at least for the present not to apply for consent to use the Earnley site due to the amenity value of the West Solent and is at present seeking conventional alternatives.

Ultra-centrifugal method

THE Netherlands Minister for Education, Arts and Sciences stated recently that the enriched uranium obtained in the FOM (Fundamental Matter Research) Laboratory by the ultra-centrifugal method is exclusively for scientific purposes both as regards quantity and the degree of enrichment. He added that these stocks constitute no danger to the population. He also explained that the ultra-centrifugal process is intended to determine the importance of ultra-centrifuges for the production of isotopes for scientific and industrial purposes. The question of international co-operation was under consideration, he said.

At Trawsfynydd

Due to their huge size the 12 350-ton heat exchangers for the Trawsfynydd nuclear power station are being fabricated on site. Manufacture is being carried out by International Combustion, Ltd., with the aid of Yates Plant manipulative equipment and welding columns and booms. Completed single strake heat exchanger sections are received on site and welded together on five sets of rotators, to form double strakes. These are then lifted on to either of two final assembly travelling rotator sets for the final welding operation. When completed, the heat exchanger can be towed out of the site erection shop on its supporting rotators and trolleys

PEOPLE

J. H. Bannier

A. G. Wray

Donald C. Power

MR. DONALD C. POWER, chairman of the board and chief executive officer of General Telephone and Electronics Corporation, and **MR. FRANK J. NUNLIST,** vice-president, operations, of Worthington Corporation, have been elected to the board of directors of Worthington Corporation. They will fill vacancies resulting from the retirement of **MR. LEWIS L. CLARKE** and **MR. HUNTER S. MARSTON.**

DR. NED S. RASOR and **DR. DONALD E. McKENZIE** have been appointed director and associate director respectively of the Energy Conversion Department recently formed by Atomics International. This new department will concentrate on the generation of electricity directly from heat such as from nuclear reactors without the use of rotating machinery. Substantial projects are envisaged in the field of thermionic devices such as novel lightweight batteries and fuel cells. Dr. Rasor was formerly in charge of materials research for the PLUTO (nuclear ramjet) project. Dr. McKenzie has been responsible for researches into the high-temperature chemistry of ceramics, fused salts and glasses, and the chemistry of liquid metals and organic compounds.

DR. W. E. PARKINS has been appointed associate technical director of Atomics International and will share responsibility for direction of development programmes, especially in the fields of advanced nuclear reactor systems and new technologies. Dr. Parkins was formerly director of the organic reactors department of Atomics International and is a director of the American Physical Society.

PROFESSOR V. F. WEISSKOPF was recently appointed as the fourth director-general of CERN at the 18th Council Meeting. Professor Weisskopf will serve for two years from August 1st, 1961 and succeeds **DR. J. B. ADAMS,** who returns to the U.K. as director of the Culham Laboratory for Plasma Physics Research. In 1960 Prof. Weisskopf was granted leave of absence from his post at the Massachusetts Institute of Technology and joined CERN as scientific member of the directorate which was being set up to assist CERN management. Prof. Weisskopf has written many important works and is a corresponding member of the French Academy of Sciences, a member of the National Academy of Sciences in the U.S.A. and until the end of 1960 was president of the American Society of Physics. The German Society of Physics awarded him the Planck medal in recognition of his work.

The officers of the CERN council and its committee were recently elected by representatives of the 13 member states at Meyrin (Geneva). **MR. JAN WILLEMS** (Belgium) was elected council president, **PROF. EDOARDO AMALDI** (Italy) and **MR. JAN HENDRIK BANNIER** (Netherlands) were appointed Council vice-presidents, **PROF. CECIL POWELL** (U.K.) is the new chairman of the Scientific Policy Committee and **DR. W. H. ALEXANDER HOCKER** (Federal Republic of Germany) is to be chairman of the Finance Committee. At present the 13 member states of CERN are: Austria, Belgium, Denmark, France, Greece, Italy, Norway, the Netherlands, the Federal Republic of Germany, the U.K., Sweden, Switzerland, Yugoslavia, and Spain.

Shell-Mex and BP, Ltd., have announced the appointment of **MR. A. C. DURIE** as general manager, industrial sales. **MR. E. RENDALL** has been appointed assistant general manager, industrial sales. The appointments have also been announced of **MR. A. L. KING,** MBE, as general manager, operations, and of **MR. S. D. COLWELL** as assistant general manager, operations.

Two medals have been awarded to **SIR CYRIL HINSHELWOOD,** OM, FRS, one by the Society of Chemical Industry and the other by the Royal Society. The Royal Society's award is a new gold medal to mark the tercentenary of the Society and will be awarded every three years to "the individual who in the opinion of the Council (of the Society) shall have made the most significant contribution in the field of pure or applied chemistry or engineering, including chemical engineering. The medal, which will be in gold, will be accompanied by a monetary award of five hundred pounds." The medal awarded by the Society of Chemical Industry is presented every two years for conspicuous services to applied chemistry by research, discovery, invention or improvements.

MR. A. G. WRAY has been appointed deputy chief engineer of Marconi Instruments and **DR. R. L. GILBERT** has been appointed advanced product engineering manager. Mr. Wray has been in charge of the company's advanced development group and responsible for the development of multi-channel microwave test equipment and atomic power instrumentation. He joined the company in 1944 and was appointed company physicist in 1952. Dr. Gilbert will now be responsible for nucleonics, temperature scanning, and X-ray image brightening equipment. His main concern will be instrumentation for the Hinkley Point atomic power station.

MR. DAVID V. R. TOLL has recently been appointed special assistant to Mr. Sterling Cole, the director-general of IAEA. Mr. Toll is an American who since 1956 has been staff counsel of the Joint Committee on Atomic Energy of the United States Congress. He was an advisor in the United States' delegation to both the first and the fourth sessions of the Agency's general conference (1957 and 1960). A graduate in electrical engineering from the United States Naval Academy, Maryland, Mr. Toll also has a degree.

MR. D. K. FRASER, joint managing director of G. A. Harvey & Co. (London), Ltd., has been appointed managing director. **MR. H. E. COOPER** has relinquished his office of joint managing director but remains a director of the company.

MR. EARL D. NEEDHAM has been made director of material for Atomics International. He succeeds Mr. K. B. Gay. Mr. Needham is to be responsible for purchasing, transportation and warehousing. He joined Atomics International in 1958.

MR. J. S. LANGLANDS has succeeded Mr. A. S. Black as area manager for Scotland for GEC. In 1948 Mr. Langlands went to Canada and formed the British General Electric Co. (Canadian) on behalf of GEC and was vice-president and managing director of that company. He returned to this country in 1954 to take up the appointment of assistant area manager, Scotland.

MR. W. BRUCE has moved to a new appointment as sales manager to Limi-Torque Valve Controls, Ltd., from the parent company, Opperman Gears, Ltd., which he joined in 1951 as a Technical representative. He was apprenticed at David Brown-Jackson and became a graduate member of the Institute of Production Engineers at Salford Royal Technical College, before the war. He served in the Royal Naval Air Service at home and overseas from 1940-1945, and returned to David Brown-Jackson as a technical sales engineer.

Equipment and Materials

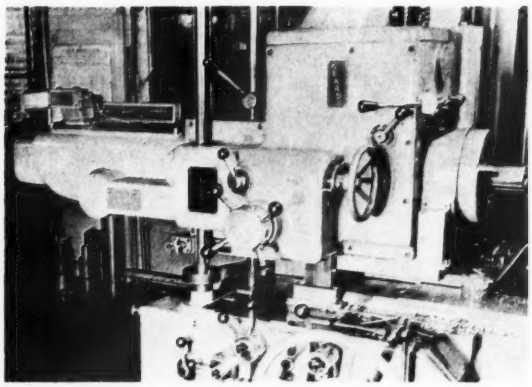
Items published in this monthly feature are compiled from manufacturers' current literature. Readers requiring further information should use the form at bottom of the page. Manufacturers are invited to send literature or details of their products for inclusion in this feature.

Optical Depth Control

A new aid to co-ordinate setting, in the form of an Optical Depth Control to the travelling spindle is now available for Kearns Series 45 or 72 horizontal boring machines, and No. 2 or 3 Kearns patent horizontal boring machines. This system employs an accurately graduated rule and large projection screen, measuring 4 in. × 1½ in., avoiding completely eye strain caused by peering through a microscope. The fixed scale, is mounted on the spindle feed bracket. An optical unit carries the large projection screen on which a vernier sub-divides the magnified main scale readings into thousandths of an in. or one hundredths of a millimetre. Clamping of the bearing to the travelling spindle enables the spindle to be gripped in the most convenient position for the workpiece to be machined. A further fine adjustment on the scale mounting enables the readings to be set at zero or the nearest whole number. For most work the 12 in. or 305 mm traverse provided will be sufficient, but reclamping of the rear spindle bearing allows the full spindle traverse to be used. The large projection screen is protected by a toughened glass plate. Parallax errors are impossible because both the vernier and the image of the scale are on the same surface. Screen readings are transposed and reflected by a mirror. Using normal spindle feed rates continuous readings may be taken from the main scale to 0.1 in. or .1 mm. Final reading and setting is direct to .001 in. or .01 mm. A pneumatic time switch is provided to protect the optical lamp. **(FEB 1)**

Fielden Servograph

The Fielden Capacipoise Servograph is an extremely compact, inexpensive, servo-operated recorder available in a.c. or d.c. current ranges. It has been designed to fit into the Capacipoise range of instruments, all of which operate from a supply of 12v d.c. but two models are available, one requiring an external d.c. supply and the other incorporating its own power pack. The latter may be operated from the normal 240v 50 cycles mains supply. The size of the instrument has been chosen to give a chart 6¼ in. diameter which is large enough for the vast majority of applications whilst the recorder itself will occupy a minimum of panel space. All instruments are fitted as standard with a central indicating pointer moving over an arc of 300°. The indicator scale length is approximately 15 in. and is easily readable from a considerable distance. One or two electrical contacts, which can be used for alarm or control purposes, can be fitted and other forms of control are also available. Both the pen and the indicating pointer are motor driven and no errors are introduced by pen to paper friction or by the weight of the pen. The servo-motor also ensures that extremely small increments are faithfully reproduced on the chart. In the design of the recorder, moving parts have been reduced to the absolute minimum. Gearing between the servo-motor and the central indicating pointer has been eliminated by the use of a rim drive and a simple quadrant connects the indicating pointer to the recording pen. With this new modern design the instrument is very much more simple than conventional servo-operated recorders and can be depended upon to give long, trouble-free service without attention. **(FEB 2)**



Boring machine fitted with the new Optical Depth Control introduced by H. W. Kearns and Co., Ltd.

Reciprocating Compressor

The range of vertical reciprocating compressors, designated Type 300/A manufactured by The Bryan Donkin Co., Ltd., Chesterfield, covers the following pressures:—

Stroke in.	*Single stage lb/sq.in. gauge*	*Two-stage lb/sq.in. gauge*	*Three-stage lb/sq.in. gauge*
6	50	250	1,200
8	45	225	975
12	40	200	750

The 6 in. stroke compressor can be supplied as a single, two or three crank machine and the 8 in. and 12-in. stroke machines are made with either two or three cranks. The

Cut along here

To: NUCLEAR ENERGY

147 Victoria Street, London, S.W.1

Please send further details of the following items in the EQUIPMENT & MATERIALS *feature for February, 1961*

Item No's ....

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IS THIS ENQUIRY CONFIDENTIAL? YES | NO

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Position .....

Firm .....

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maximum flow of free air obtainable with the 12 in. stroke compressor at a discharge pressure of 100 lb/sq.in. gauge is about 3,600 cu.ft/min. Drop forged connecting rods have been used in accordance with modern practice. These are made in I-section and have a high strength/weight ratio. The use of drop forged connecting rods, as well as reducing production costs, also leads to a reduction of the out-of-balance forces. Special attention in design and production has been given to the interchangeability of parts. The big end and main bearing are precision components, with thick wall steel backs and white metal linings, and they can be fitted easily without bedding in or scraping. The compressors have been designed for continuous running and there is little need for maintenance. Their structure is such, however, that they can very easily be dismantled and reassembled for examination and maintenance when required. **(FEB 3)**

Multi-pin Connector

A new range of multi-pin connectors—the Aluminium Mark 6—is now available from The Plessey Co., Ltd. They are available in four shell sizes with a fixed and free unit in each size; both units are obtainable with either a plug or socket and are easily convertible to coupler units by the attachment of cable fittings. A single moulding of silicone rubber bonded to the housing forms the insulator and is designed to fully shroud each individual contact, cable joint and a portion of the cable dielectric. Insulation resistance between contact and earth throughout the Mark 6 range is in excess of 10^6 megohms at 500v. Contacts in this new range of Plessey connectors are silver plated brass and socket inserts are designed to give a line contact with equal mating loads irrespective of the length of engagement. A damage prevention device is also incorporated in all socket inserts. A standard voltage rating of 1 kV r.m.s., irrespective of contact class, applies to all four sizes of Mark 6 connectors, at ground level, reducing to 350v at altitudes of 70,000 ft. Current ratings range from 5 to 12 amps and the connectors have been proved satisfactory for operation in ambient temperatures between −55°C. and +155°C. A special feature of these connectors allows them to be used in four alternative positions by merely varying the position of the bayonet couplings. This feature prevents mis-coupling to wrong units and also prevents mis-mating. **(FEB 4)**

Monitoring Devices

The use of electromagnetic relays in monitoring devices on circuits at very high voltages can introduce serious problems with regard to satisfactory insulation. A neat solution to these problems has been devised by an electrical engineer at the Harwell Atomic Energy Research Establishment of the UKAEA, and is the subject of a patent application. Quite simply, the invention replaces the relay by a beam of light and a photocell. The beam is produced by a neon glow-discharge tube inside a plastic housing which defines the path for the light beam, acts as insulation and excludes external light. The circuit being monitored incorporates the neon tube and is arranged to energize the latter in case of fault conditions. The tube strikes and the light emitted causes the photocell to operate an ordinary low-voltage relay which in turn operates an alarm. In one embodiment, the device operates satisfactorily with as much as 8 kV between the neon tube and the photocell, the low-voltage relay being near to earth potential and thus presenting no insulation problem. For use at still higher voltage where insulation problems require the distance between neon cell and photocell to be increased, a light-guide of glass or methyl methacrylate rod may be inserted to give better light transmission. **(FEB 5)**

Esso Lubricants

A range of lubricants has been introduced by the Esso Petroleum Co., Ltd., specially for use in machinery associated with reactors in nuclear power stations. Essotron oils and Cosmos greases in this range have been selected for use at the 550 MW nuclear power station being built at Trawsfynydd for the Central Electricity Generating Board. These lubricants have outstanding resistance to the harmful effects of all forms of nuclear radiation, and they are unaffected by the hot carbon dioxide gas used as a coolant in current British commercial reactor designs. They have a high standard of purity, are free from elements which might damage the cans of the uranium fuel elements, and have unusually low vapour pressures to reduce the possibility of oil vapour being carried into the gas stream. Oils are used where possible to lubricate machinery associated with the reactor, and for many applications they are completely satisfactory. However, grease must be employed on the fuel handling machine and the control rod operating mechanism. Exposure to radiation and to hot carbon dioxide rapidly causes ordinary greases to alter in consistency. Cosmos greases are highly resistant to radiation and unaffected by carbon dioxide; they can therefore be used without oil " bleeding " from them at the high temperatures of the equipment they lubricate. **(FEB 6)**

New Elliott Monitor

Elliott Nucleonics, Ltd., have developed a new highly sensitive water radioactivity monitor, type ND.2151. The equipment measures and records the activity of solid radioisotopes dissolved in water. The sensitivity is such that a specific activity for drinking water well below the maximum permissible level for mixed fission products can be detected. The monitor consists of a sampling unit and an indicating unit. The sampling unit contains a Geiger-Muller tube surrounded by a bed of ion exchange resin. Water is passed through the resin bed at a controlled rate and dissolved solids, including any fission products present, are retained in the resin. The beta gamma activity emitted by the solid radioisotopes are detected by the Geiger tube. The output from the counter tube is fed to an indicator unit which records continuously the mean counting rate and, if required, actuates an alarm on reaching a predetermined level. The measuring circuits employ transistors ensuring a high degree of reliability. The sampling is normally carried out over a weekly period in which 20 litres of water are passed through the ion exchange resin at a controlled rate, after which the resin is replaced. **(FEB 7)**

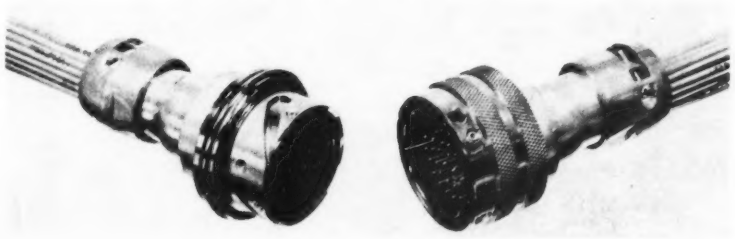
Milk Monitor

Plessey Nucleonics, Ltd., have developed a monitor for measuring the amount of radioactivity in milk. The necessity for an accurate determination is acute, especially since the safety limits for infants are well below those for adults. The equipment consists of a detector probe and an indicator unit worked either by a 12v car battery or a.c. mains. It is designed for use with standard 10-gal churns. A thin-walled Geiger-Muller tube in the probe detects both beta and gamma radiations. Two scales are used, each calibrated directly in infant tolerance levels, one from 0–3 and the other from 0–200. The indicator dial has a central zero and the two ranges are read separately on either side. A switch is provided to put either one scale or the other into operation. In this way there is no chance of confusion and the equipment may be used by unskilled personnel. **(FEB 8)**

Atomic Models

A new series of 30 lightweight atomic models are being marketed by the Griffin and George Group. Known as the Griffin Courtauld Atomic Models, they are accurately moulded in plastics and are intended for use in the study of the intricate stereochemical problems arising in synthetic and natural high polymers. Long chains can be rapidly assembled with these models and folded into complex configurations. **(FEB 9)**

New multi-pin connector by Plessey



ISOTOPE WORLD

Radioisotope development in the European Community

by W. Rojahn

NO less than 14 international conferences have been held since 1954 on the subject of research and technology in the radioisotope field. The information published after the two United Nations conferences held in Geneva in 1955 and 1958 dealing with the peaceful uses of atomic energy have been particularly widely circulated, likewise the reports read at the 1957 UNESCO Conference in Paris, and at the two congresses which have been organized by the International Atomic Energy Agency, one in Warsaw in 1959 and one held this year in Copenhagen in collaboration with UNESCO. The copious material arising out of these conferences, together with the numerous other publications which have appeared on this subject, clearly demonstrates the enormous variety of uses, so far only partially examined and exploited, to which radioisotopes can, in theory, be put, in research medicine and agriculture as well as in industry.

Tracers

It would be an impossible task to attempt to give a complete list of all the cases in which radioactive isotopes may safely be added in infinitesimal quantities to inactive substances as tracers or in which small parts of a substance may be activated by irradiation in order to record biological, chemical, metallurgical, mechanical and other processes by means of radiation measuring equipment, radiosensitive film or spectrum analysis. As examples showing the considerable range of possible applications of radioisotopes, mention might be made of the methods which are used to bring out fingerprints in the detection of crime and of the suggestions which have been made to use them as labels in the marking of securities to facilitate the exposure of counterfeits.

The use of extremely sensitive measuring processes also makes it possible to record changes brought about in radioactive radiation as a result of the penetration of matter or of reflection. As the effect of matter on radiation depends on the properties as well as on the dimensions and geometrical arrangement of the substance irradiated, there is a whole series of possibilities available, particularly in industry, *e.g.*, for non-destructive materials testing, for thickness, quality and volume measurements, in level gauges and package monitors as well as for chemical analysis.

A further range of possibilities results from the fact that matter can be modified by the effect of ionizing radiations, so that chemical reactions may be influenced, *e.g.*, in polymerization or chlorination, materials can be sterilized, radioactive batteries and light sources can be produced and air, for example, can be rendered conductive for the removal of static electricity.

The wide scope of the radioisotope field is also shown by the fact that the International Atomic Energy Agency found it necessary to deal with this subject in several stages, organizing several conferences for the purpose. The conference held in Warsaw in 1959 was designed to give a general survey of the uses to which strong ionizing radiation sources can be put in industry. The Copenhagen Conference in 1960 dropped this subject and went on to report on the progress achieved in the further applications of radioisotopes in industry and in the natural sciences, excluding living organisms. A third conference to deal with the medical and biological aspects of the problem is scheduled for 1961.

In examining the progress made in radioisotope research and technology, we must never lose sight of the multiplicity of the possible applications. Notwithstanding the many extremely valuable results which have been achieved, it must be realized that an enormous field still remains to be explored.

Radioisotope Manufacture

Within the European Community, Belgium and France are using nuclear reactors and Holland is employing a cyclotron to manufacture artificial radioisotopes for commercial purposes. Furthermore, the German Federal Republic and Italy process imported active substances to make saleable products, although on a rather smaller scale. Both these countries, however, plan to use nuclear reactors eventually for the manufacture of radioisotopes on a commercial basis; in Germany this will be done, as is known, in Karlsruhe and Stetternich.

The cost of processing irradiated materials to make saleable products can be precisely determined; this involves, for example, such items as the separation of required types of atoms from other substances contained in any radiated product, *i.e.*, the purification of such products, qualitative measurement and also packing. On the other hand, only rough estimates can be made of the pre-production stage costs, *i.e.* for the actual radiation. The requisite particle accelerators or reactors are often used primarily for other purposes, namely for research or power production. Thus, exact estimates can be drawn up only in respect of additional investment relating specifically to radioisotope production and also possibly of part of the overheads, *e.g.*, for staff employed exclusively for this purpose. A large proportion of the irradiation costs, particularly the expenditure for the provision of the neutron flux in reactors, can only be estimated on a more or less arbitrary basis. In actual fact, Community producers have not fixed their prices solely in accordance with production costs, but rather on the basis of competitive import prices, which are on the decline.

Sales

Some 3m. DM worth of radioisotopes were sold by the Community in 1959, involving more than 15,000 individual consignments, of which about 30 per cent. were exported to non-Community countries. By way of comparison, it will be noted that over the same period, the largest radioisotope exporter in the world, the British Atomic Energy Authority, despatched around 35,000 consignments having a value of approximately 12m. DM.

The value of the radioisotopes imported annually by the Community from Britain, the United States, Canada, Norway and other non-Community producers would also stand at around 3m. DM. At the moment, the Community still relies on imports for its supplies of high intensity radiation sources, *e.g.* cobalt-60 sources of 1,000 curie and over.

The Community is already manufacturing a considerable variety of products. The French Atomic Energy Commission alone produces about 110 various artificial radionuclides and over 150 different tracer molecules. In addition, there are plants at Mol and Amsterdam, which produce partly the same radionuclides as in France and about 30 others as well. About 180 radionuclides and more than 1,400 tracer compounds are now available on the world market.

Once commercial radioisotopes can be obtained from fission products, *i.e.*, from burnt-up reactor fuels, particularly caesium-173, it will be possible to step up production capacity and cut costs accordingly. A semi-industrial experimental plant of this type will shortly be put into operation in France. At the abovementioned conference in Copenhagen, Belgian scientists reported on preparatory work carried out in this field.

Apart from the producers of radiation sources and tracer substances, a word should be said about manufacturers of radiation-measuring equipment and other radioisotope apparatus. Together with governmental and public research centres, this branch of industry carries out a considerable part of the development work and, in boosting the sale of its products, through technical publicity campaigns, it makes a vital contribution to ensuring that radioisotopes are used on an ever-increasing scale. The Community has more than 50 producers and suppliers working in this field. These, however, also put on the market other equipment which does not involve the use of radioisotopes. Their economic activity is scarcely distinguished from other, conventional branches of industry where production entails comparatively high development costs.

Radioisotope Marketing

Although producers of radioisotopes and of accessory equipment have taken account of the extensive range of possible applications and have built up a production capacity offering large-scale high quality supplies, the market has nevertheless not expanded to the extent that was predicted at the two Geneva conferences.

In the six countries of the European Community there are, at the moment not more than 2,400 users of radioisotopes, about half of them research centres and clinics. In view of the precautions which must be taken to prevent radiation damage, radio-

isotopes for diagnostic and therapeutic purposes can only be developed and disseminated on a comparatively long-term basis. The fact, therefore, that about 70 per cent, of all individual consignments relate to this field at the present time, is indicative of the progressive spirit of modern medicine. It must be borne in mind, however, that this number of individual consignments includes very small amounts with low activities, which cannot be stored owing to the short half-lives which are frequently involved. It will likewise be a fairly long time—again because of health protection considerations—before methods for sterilizing foodstuffs by irradiation can be successfully employed.

Potential use

The remaining 1,200 or so industrial and commercial users belong to 18 branches of the economy, which, in the Community, incorporate a total of about 1.2m. enterprises. Assuming that not only 70 per cent. of these enterprises, but other branches of the economy too could profitably make use of isotopes, as has been shown in American and British publications, then it can be estimated, admittedly only very roughly, that the present figure of 1,200 users could possibly reach the million mark.

In support of this estimate, it is worth pointing out that enterprises which have started using radioisotopes have derived considerable economic advantage from so doing, saving labour and materials, stepping up the tempo and efficiency of production processes, increasing the speed and accuracy of measurements and improving the quality of their products.

Statistics for 1957 show that French industry was able to achieve a saving in production costs of approximately 4m. DM thanks to the use of radioisotopes. This figure would probably be much higher now, since the number of consignments despatched by the French commission has more than doubled in the last three years.

Similar enquiries carried out for 1958, in which the data submitted by individual enterprises—subdivided according to the branches of industry to which they belong—were extrapolated and collated, showed that savings in respect of production costs amounted to around 2,000m. DM annually in the case of the United States and the Soviet Union and in Britain to about 45m. DM. Even more weight, however, should perhaps be given to the data relating to concrete instances obtained as a result of the representative surveys carried out for these countries and reported on this year by H. J. Marcinowski in the journal *Kerntechnik*.

Estimates predicting considerable future increases in the sale of radioisotopes in these countries indicate that, at the present time, developments have not progressed much further than in the European Community. As against the abovementioned total of 1,200 industrial and commercial users in the Community, there are about 2,500 in the United States and about 800 enterprises in Britain. These figures present us with an incomplete picture, inasmuch as one enterprise may operate a number of plants using radioisotopes. In the German Federal Republic for example, there are about 40 firms using roughly 400 level gauge and package monitoring units. It is also worth noting that with regard to the industrial use of radioisotopes in the nuclear sector of the economy, the Federal Republic tends to be ahead of the other Community countries; in any case, it certainly cannot be said to be lagging behind. This is a field ,therefore, where Germany is in a good position to make a significant contribution to progress within the Community.

Isotope Technology

In those countries in which radioisotope work is carried out, research and development is supported by the state in the public interest. As you know, the Euratom Commission also has resources at its disposal to be used for this purpose. The expansion of radioisotope technology in industry and trade, however, is impeded by a number of obstacles which are not all attributable to the expenditure involved in the creation of the necessary scientific and technical infrastructure.

In discussing the question with firms engaged in the supply of this type of nuclear equipment, one gets the impression that one of the main factors preventing them from branching out is the lack of familiarity with radioisotope techniques on the part of potential users coupled with the fear of radiation damage, which, however, either would not arise at all at very low intensities or which could be prevented by foolproof protective measures. Unjustifiable apprehensions of this sort are also liable to spread to buyers of industrial products manufactured with the help of radioactive substances. The possibility cannot be ruled out, therefore, that some enterprises may decide to forgo the advantages deriving from radioisotopes on account of the fact that their customers may be deterred from placing an order because they think that a given product contains a dangerous amount of radioactivity.

Information Centre

In view of this situation, the Euratom Commission recently decided to set up an information centre on radiosotope technology. It is also trying to find out what is being done in member countries to overcome these difficulties, and it is prepared to take the necessary steps to supplement the work which is being carried out by the parties concerned. A centralized Community publicity and propaganda campaign launched along suitable lines would possibly be more effective than individual campaigns undertaken in each of the member states. Joint action would make it possible to pool knowledge and to save money.

In assessing prospects, however, it must not be forgotten that in many cases there is no need for further facilities for the distribution of information. The considerable publicity which has been given to radioisotopes is certainly not overlooked in industrial circles. Many firms have at least a fundamental grasp of the uses to which radioactive substances can be put. There are good chances of their becoming users of radioisotopes if operationally tested and possibly also mass produced equipment, *e.g.* package monitors and level, thickness or density gauges, becomes available and proves suitable for their purposes. However, when tests have to be carried out for the first time or have to be adapted to different manufacturing processes, the expense of preparatory testing, measurements, calibrations, etc., is liable to be considerable, even in cases where fabrication techniques are known and the appropriate instruments are available. It would be useful all round if Euratom were to contribute to the considerable expenditure involved, provided the Commission were free to pass on to interested parties within the Community practical test results as well as the information obtained in the course of preliminary work. This approach might not only enable costs to be cut; it would also lead to a gradual reduction of the projects requiring Euratom participation. Furthermore, in offering such participation, the Euratom Commission would bear in mind that it is perfectly possible for projects involving the use of radioisotopes for the purpose of gaining information on manufacturing processes which are carried out by conventional means and are thus not particularly attractive to suppliers of nuclear equipment, nevertheless to be extremely useful for industry generally.

Help to Industry

To make it easier for industry to put forward concrete projects, the Commission will make known the contractual lines along which it is prepared to work together with individual firms for the futherance of its own tasks as entrusted to it under the Euratom treaty as well as of the interests of the enterprises concerned.

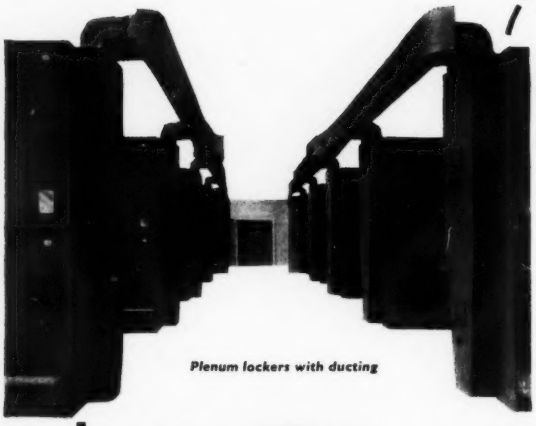
Research and development will continue to require government support. However, with the exception of any governmental assistance which may be required to start off given projects, it is up to the industry itself to bring about the expansion of radioisotope technology. Many problems can be solved only by industry, through close co-operation between engineers from the manufacturing plants concerned and experts on radioisotope technology. The obstacles standing in the way of further progress are, however, certainly neither so numerous nor so great as the possibilities which the use of radioisotopes affords.

Study of Endemic and Tropical Diseases

THE USE of radioisotopes in the study of endemic and tropical diseases was discussed at a symposium jointly convened by the International Atomic Energy Agency (IAEA) and the World Health Organization (WHO) and held recently at Bangkok, Thailand. Papers presented covered the nutritional, haematological, entomological and parasitological problems in tropical medicine as well as electrolyte and endemic goitre problems. Two of these papers from Thailand and the Philippines reported the results obtained under research contracts. These contracts are part of IAEA's overall programme of using atomic energy to fight diseases prevalent in tropical and subtropical regions. Further research contracts in the field of tropical medicine have so far gone to institutes in Greece, Iraq, Israel, the Union of South Africa, and Venezuela.

Isotope Fellowship

THE 1,000th IAEA fellowship has gone to Dr. Lionel P. P. G. Siriwardene of Ceylon who will undergo a course of training at the isotope school at Harwell studying the application and production of radioactive isotopes, radiological protection, and especially the application of radioisotopes to metallurgy. Dr. Siriwardene graduated from the University of Ceylon and the University of Cambridge. He has published a number of papers on metallurgy. At present he is a lecturer at the University of Ceylon and is doing research on the smelting of Ceylon iron-ore. When he has been trained, Dr. Siriwardene is to take charge of the radioisotope laboratory at the University of Ceylon. This laboratory is at present being constructed by IAEA under a technical assistance project. Mr. F. H. Kendall, an IAEA radiochemistry expert is at present assisting the Ceylon authorities in the implementation of this project.



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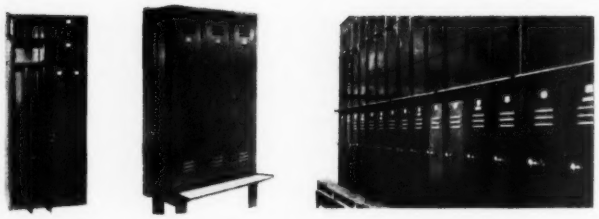

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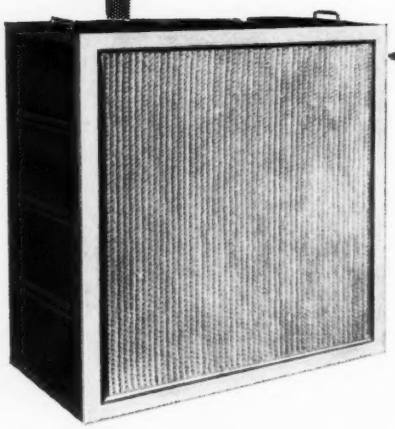

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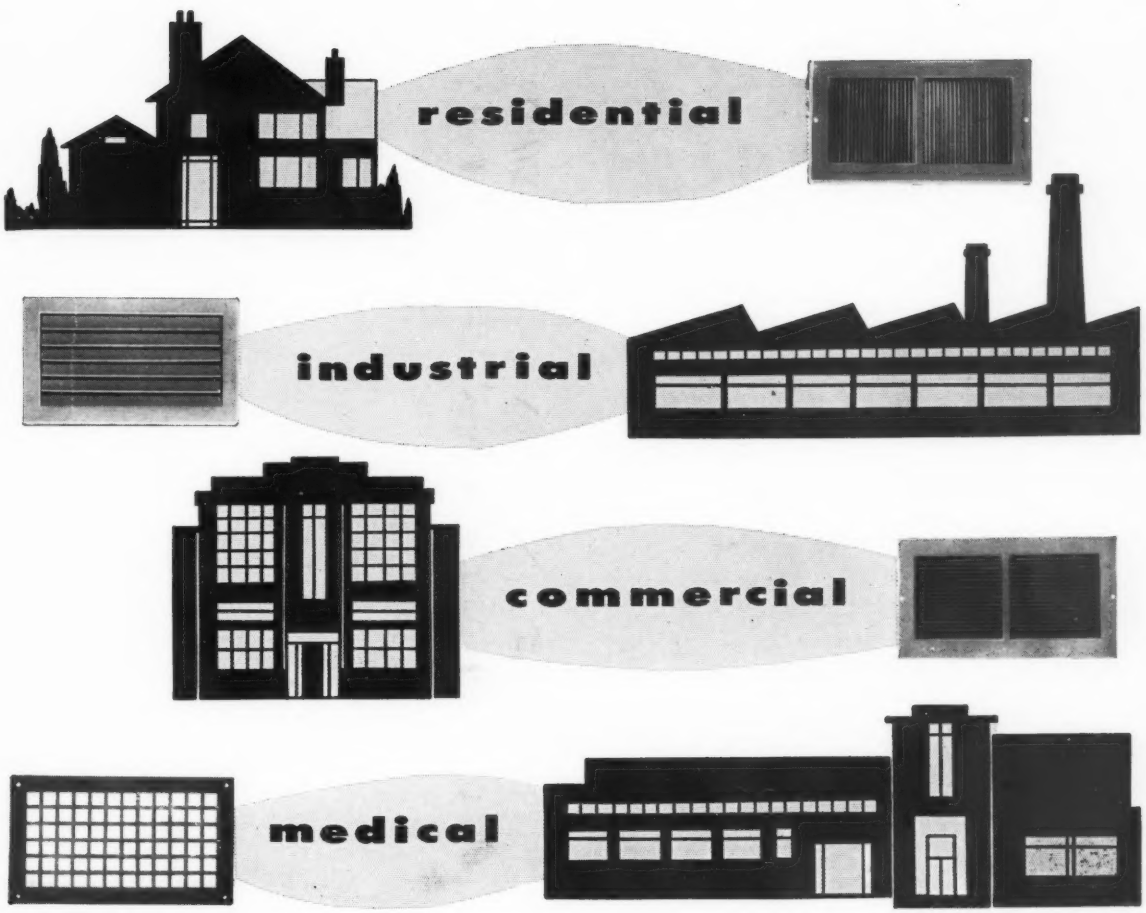

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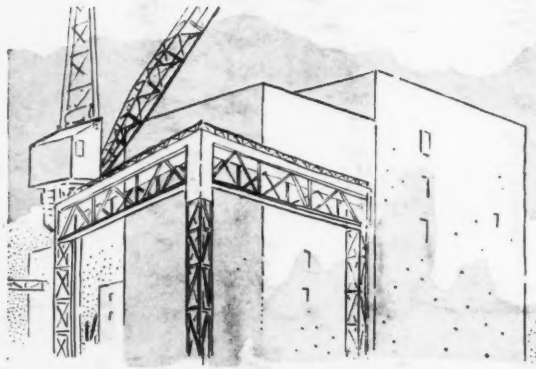

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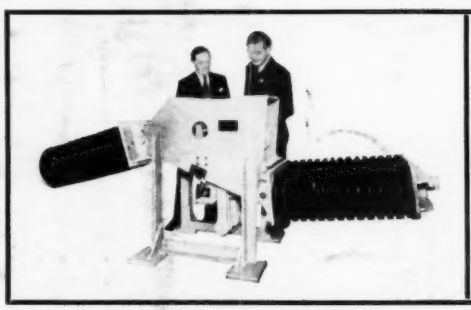

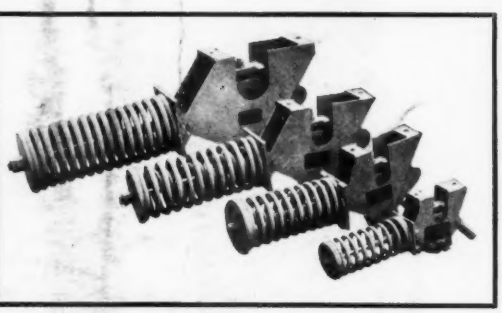

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